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A SYMPOSIUM

PART II

THE STATE OF RUSSIAN SCIENCE TODAY

III

IMPRESSIONS FROM A RECENT MOSCOW VISIT

KATHLEEN LONSDALE

Dr. Lonsdale is one of Great Britain's best-known Quakers, as well as being a distinguished scientist. She recently journeyed to Moscow with a delegation of British members of the "Society of Friends," on an unofficial "peace mission." Here she reports on her impressions of Russian scientists and their present relations with the West.

SCIENCE is international by its very nature, since truth knows no frontiers and all scientists owe much of the foundations of their knowledge to men of science of varied nationalities. Moreover, those who know the Russian people best tell us that as individuals they are by nature some of the most friendly of all peoples. It would seem, therefore, the simplest of all tasks to be friendly with Soviet scientists. But of course it isn't. To begin with, they don't answer letters. Of course, they are not unique in this. American scientists are almost as bad; but not so consistently. Some Americans are quite good, and of no American of my acquaintance can it be said that he *never* answers a letter.

Then, again, the Russians hardly ever come to international scientific conferences. This must also be qualified. In 1946 we held a Crystallographic Conference in London, and scientists came to it from all over the world, including both Germany and Russia. We decided to form an International Union of Crystallography, to start an international journal and to begin the preparation of some international tables. There were also a number of other joint projects. The four Russians took a most helpful part in the discussions; they suggested the name *Acta Crystallographica* for the journal, which was accepted, and they nominated Russian representatives on all the various committees. We arranged for them to see something of the research departments in our universities and to visit British firms making crystallographic apparatus, and they went back to Russia with our good wishes.

They were a little stiff with us when they arrived. They had been held up in Berlin owing to some official misunderstanding and were late. But by the time they left England they felt that we wanted to be friendly, and I remember one of them saying to me: "We *must* keep in touch with each other, now that we have really got to know one another." I have never heard from him since then, although I regularly send him reprints of published papers. Shortly after they got back to the Soviet Union, the Russians withdrew from everything, and they never actually joined the International Union of Crystallography that they helped to form. A number of copies of the *Acta Crystallographica* go regularly into the Soviet Union, so that they do know something of what we are doing, but they never send us papers for publication.

INTERNATIONAL MEETINGS

In 1948, the International Union of Crystallography held its first official congress at Harvard, but although it was well publicized in the *Acta Crystallographica* and all crystallographers were invited, the Russians did not come. Incidentally, the French crystallographers did not come either, because Professor Wyart, one of their most distinguished representatives, had his visa refused, and the French withdrew all their papers in protest. Professor Wyart's only crime seems to have been that he had once published a book on the structure of atoms, which was known to have been translated into Russian! So perhaps it is doubtful whether any Russians would have been given visas, even if they had wanted to come to the USA. The fact was that international feeling was already getting bad.

Our next Congress was due to be held in the summer of 1951, and it was felt that if we made Stockholm our meeting-place, then it really ought to be possible for Soviet scientists

(and French!) to come to it quite easily. At first I was very hopeful. To be sure we had had no contacts with them since 1946, but in September 1950 I was invited to go to the USSR with a party of women of all sorts of professions. This sounds as if I were a known Communist, but, in fact, it proves the exact opposite. The Russians were beginning to realize that glowing reports from Communists or fellow-travelers cut no ice, and they therefore included in their invitations non-Communists—a practice which drew the following comment from Edward Crankshaw in the *Observer:*

"Anyone who is invited, apparently in all innocence, to go on one of these conducted tours should . . . ask himself whether he is likely to be proof against the whole apparatus of the Soviet state putting on a show, as only Russia can put on a show, for the express purpose of taking him in—as so many good and intelligent men and women have been taken in before him. . . ."

Anyhow, I couldn't go, but what I did do was to explain to the leader of the party who went that I was tired of having no means of contact with scientists who were perfectly friendly when they met us, and I asked her whether she would be willing to take with her a book and some papers for me and ask VOKS to forward them to the person to whom they were addressed: Professor Shubnikov, the director of the Crystallographic Institute of the Moscow Academy of Sciences. Then, at least I should know that they had got inside Russia. She agreed without hesitation and I had a message later saying that she had done her part. The book was a complimentary copy of my *Crystals and X-rays,* and the papers were a list of English crystallographic terms, of which I wanted the Russian equivalents to print in the *International Tables for X-ray Crystallography,* of which I was chief editor. I could, of course, have got these in England, but what I was really aiming at was Soviet cooperation. There was silence for nearly four months, and then, greatly to my surprise, I got back my list by post, early in 1951, together with the Russian words that I had asked for; and I also got, separately, copies of *two* recently published Russian books on crystallography. Incidentally, and perhaps it is not unfair to say, typically, these were inscribed inside with the names of two other British crystallographers to whom copies bearing my name had been sent! We sorted them out quite amicably.

Next I sent a personal invitation, through the Soviet Embassy in London (I went to see the Counsellor, who was most courteous and helpful), to ask the Soviet crystallographers to come to Stockholm. I got back a cable to say that they were considering it, and then there was a complete blank, which no further enquiries could fill, and to my great disappointment the Russians didn't come. Needless to say, many of my fellow-crystallographers were not surprised and felt that it had been a waste of time to make the attempt—a thoroughly unscientific attitude.

SOVIET ATTENDANCE

Some Soviet scientists do belong to international unions, although their attendance at conferences is always erratic. Sometimes they come to them, but without giving any previous notice of their intention to do so, which makes difficulties for the organizers. On the other hand, the USSR Academy of Sciences invited the International Astronomical Union to hold an assembly in Leningrad in August 1951. The Union agreed to do so, and made all the preliminary arrangements; and then, in January 1951, the Executive Committee indenitely postponed the assembly. The reasons given were "difficulties of travel and planning" and the "paramount importance that the International Astronomical Union be kept intact from any political entanglements and complications." The Astronomical Council of the USSR Academy, which had been able to give a guarantee that no Soviet visa would be refused to any scientist whose name was put forward by the International Union, greatly resented the decision of the Union's Executive Committee and published all the relevant documents in the *Astronomical Journal* of the Soviet Union (1951), with comments which, of course, may or may not be justified. It certainly does seem a pity that when, for once, the closed door had been opened, it should have been slammed again so decisively by the West.

JOURNEY TO USSR

In the middle of July 1951, I did go both to Moscow and Leningrad as a member of a Quaker team having wide professional interests. We had asked for the invitation, because we wished, not so much to see conditions in the Soviet Union for ourselves, as to meet Soviet politicians, church leaders, editors, educators and see what we could do, even if it were only a little, to break down the barriers of misunderstanding and suspicion between us. Our proposed visit was announced in the British press, and, as my kind of science is generally reckoned to be pretty harmless, neither the Home Office or the Foreign Office objected to my being one of the party. The Foreign Secretary did, indeed, advise us to take plenty of Quaker literature with us—advice that amused us, because Quakerism is not "for export only."

I welcomed the opportunity of being able to get into direct personal touch with Soviet scientists. I asked to be taken to the Institue of Crystallography in Moscow and to visit the Academy of Sciences. This was arranged, but my further request, to meet the chief librarian of the Leningrad section of the Academy, proved too difficult for my interpreter. I was told that there were twenty-five chief librarians and was asked which of them I wanted? "Surely," I said, "there is one who is the senior of them all?" "No," was the answer, "they are all of equal status." I gave it up; but this did

help me to understand how difficulties of correspondence might sometimes arise, through insufficiency of address on letters or parcels. A visitor to the USSR from the West is, in any case, particularly conscious of the lack of such aids to communication as telephone directories, street maps, *Who's Who*, and so on. Many people do have telephones, but they keep a private list of the numbers they normally require, and others have to be obtained through the Exchange.

At the Institute of Crystallography I met a number of Russian workers, although Professor Shubnikov and some others, including those whom I had met in London in 1946, were on holiday. We had a talk, and I asked them *why* they hadn't come to Stockholm. Their reply was that the congress had been arranged at a time which was impossible for Russian university teachers, and one added, *sotto voce*, that this had been done on purpose. I told them that the time was indeed rather inconvenient for some of us also, but that it had been arranged mainly to suit the convenience of our Swedish hosts, although all members of the International Union had been consulted; and I begged them to reconsider this question of membership. They said they would, but so far they have not joined. (I have heard that Professor Shubnikov has been very ill since then, and that may have affected consideration of the question.)

GRIEVANCES OF SOVIET SCIENTISTS

My enquiries elicited some specific grievances. One was the refusal of visas to well-known Soviet scientists to attend the Sheffield Peace Conference. I explained that, rightly or wrongly, this was regarded as a political occasion, and one on which scientists, as such, could not expect preferential treatment. This reply was received a little coldly, and the subject was not pursued.

A more serious complaint was that, following our 1946 London Conference, they had ordered crystallographic apparatus for research purposes from Great Britain, but could not obtain it. They declared that the export license had been refused, but my enquiries have not confirmed this. What does make it difficult for British firms to give satisfactory service to Soviet clients is that there is no personal or direct contact. All negotiation is carried on through the Russian Trade Delegation, and it is not possible to

find out for what kind of work the equipment is intended and whether it will be used in a very hot, temperate, or very cold climate. Any enquiry of this kind is regarded almost with suspicion. As one of the British suppliers put it to me, "A hand comes out of a fog, takes a piece of apparatus, and vanishes. We don't even know whether it has got to the laboratory that ordered it, or not. . . ." Anyhow, none had got to the Moscow Institute of Crystallography. They had subsequently built their own apparatus, which they showed me, and very well built it was, too.

INTEREST IN RESEARCH

They were anxious to hear about research work being done abroad, and I gave them an account of some of the work done in my own laboratory. With the use of a blackboard we were able to dispense with the interpreter (who was only too glad to efface herself), and when those who knew no English got lost, the others helped to translate. As I spoke the room gradually filled up until finally I found that I was talking to thirty or more people. The interpreter told me afterwards that some of them had come along from the university Crystallographic Department and that they were lamenting the fact that I had only time to see the Institute of the Academy and not to visit their laboratories as well.

When I finished my impromptu talk, they asked questions. Professor Belov, who has studied the structures of complex silicates, asked if we were using three-dimensional methods of computation and how many structure factors were included in the Fourier analysis I had described. At my answer, which was that we were doing our analyses in three dimensions and had used 885 terms in the latest work, he staged a mock faint on to his neighbor's shoulder. Professor Belov, who is short and stout and has a merry face, was obviously the laboratory comedian and was very friendly. He was anxious to tell me why he believed that some recently published work from the USA and from Japan was incorrect, and he pressed on me reprints of his work and a copy of his book on the structures of minerals.

Professor Pinsker showed me an electron microscope, used also for electron diffraction, built in Moscow and incorporating a very nice arrangement for orientating and then rotating a crystal film, and he showed me some really beautiful electron diffraction rotation photographs of single crystal

"A Contribution to the 'Great Debate' . . ."

"Because they see the urgency of the situation perhaps more clearly than most, the scientists have felt obliged to take cognizance of the general world situation and of the social and political factors which bear on the problem of atomic energy. They cannot remain aloof in an ivory tower. But their judgments on social and political matters have no special authority. Scientists differ on them as much as other citizens.

"Nevertheless, every scientist who concerns himself with the effect of his work as a scientist on the community as a whole must attempt his own synthesis of the technical and social factors involved. He does not claim omniscience: what he does is to make his own contribution to the Great Debate in the hope that the free play of ideas will lead to that climate of opinion in which wise decisions may be taken."

—From an editorial in the *Atomic Scientists News*, London, November, 1951

films from which it had been possible to deduce Fourier diagrams showing the positions of the hydrogen atoms. His recent work was on the absolute intensities of electron diffraction and on the observation of dynamic effects. He could not give me reprints, but he showed me a copy of his book on electron diffraction, published in 1949, and I was later able to buy a copy in one of the numerous Moscow bookshops.

There is also work going on along the lines first begun by Professor Joffe, on crystal physics, and I was given a full account of this, illustrated by a film on crystal growth and the development of crystalline inclusions, by Dr. Lemigeyen. In fact, the work being done seemed to be the kind of fundamental research that might have been done in any university laboratory in any part of the world. Crystallography is very important from the technical point of view, but there was no pressure apparently put upon the workers in the Institute to develop pure and applied science side by side in the same laboratory.

While I was in Moscow they corrected the proofs of the Russian part of the dictionary for my international tables, and returned them to me. I had wondered whether the existence of these proofs, however harmless, among my papers might cause trouble at the frontier on my entry, but the customs official who looked through my luggage was very human, and, on finding quite near the top a copy of Hans Andersen's *Fairy Tales* (a new and delightful translation; taken with me for my bedside reading), he beamed and said, "Very good indeed," (in English) and passed everything I had without further examination. Coming out there was no examination at all. One of us had a camera and had, of course, had the films developed; but there was no suggestion that he might be trying to smuggle out any undeveloped films. We were simply accepted as decent, honest people.

RECEPTION GIVEN

The day after my visit to the Institute I attended a reception at the Academy of Sciences in Moscow, arranged for me at very short notice. I had spent the afternoon at another meeting, and I was worried because the car that was to take me to the Academy was very late. But none of the Russians were in the least perturbed: what is time, that we should concern ourselves about it? Professor Shubnikov had returned especially to meet me from his holiday on the Black Sea —a gesture I greatly appreciated. He told me that the Institute of Crystallography was to be rebuilt and that he hoped that I would return in three years' time, if not sooner, to see the new laboratories.

The reception was rather a difficult occasion, consisting, as it did, of a succession of public speeches by the Secretary (the President and Vice-President both being away on holiday) and myself, alternately, made through an interpreter, around a large teatable. After I had asked for, and received, an interesting account of the position of the Academy in Russian life (the President has considerable political power, as he has the status of a Minister), I was asked about the relationship between the Royal Society and the state, in Great Britain. Then I asked what, in their opinion, could contribute most to the improvement of scientific international relations. This opened the floodgates, and I received such a list of their grievances, complete with documentation, that I felt, as I remarked ruefully, rather like a whipping-boy. This analogy gave the interpreters a bit of trouble and restored the good humor of the occasion.

DIFFERENT METHODS

Many of our difficulties arise from our different ways of doing things, and our totally different ideas as to what constitutes common courtesy. For instance, their method of establishing library contacts seems to be to send out, to *all* university libraries, one or more numbers of a scientific journal with the suggestion (no doubt in Russian, and why not?) of an exchange of periodicals. If no reply is received from perhaps one-half or two-thirds of their correspondents, this is regarded as a slight directed at their country. We lay more stress on the regularity of exchange between a few important libraries.

They had taken great offense at the fact that visas had been refused for two of their three delegates to attend the five hundredth anniversary of the founding of Glasgow University. We heard of this, indeed, from all quarters, and it was not until my return to England that I learned the full facts. The decision to give only one visa was not an arbitrary one on the part of the Foreign Office, which acted in accordance with the wishes of the university authorities. The explanation, which I did not know at the time, was that the USSR Academy had, in fact, only been invited to send one delegate and that they had not replied to repeated invitations until twelve days after the closing date for such replies. On the other hand, their three proposed representatives would undoubtedly have really represented the thirty-two universities of the USSR (six of whom had been separately invited but had not replied).

Time seems to mean *nothing* to the Russians: as my experience shows, they could lay on a reception at almost no notice, and it would simply not seem to them discourteous to ignore a "final date" for replies, which was over four months before the actual date of the celebrations. What did seem discourteous and indeed insulting to them was the refusal of the visas and the fact reported by their one delegate, Professor Engelhardt (whom I met at the reception), that when he presented himself at the airport on arrival in England, he was told curtly, "A week will be more than enough," for his stay in Great Britain, and his passport marked accordingly.

Professor Engelhardt, who speaks very good English, was very pleased at the cordial welcome he had actually received from the authorities and scientists of Glasgow University, but was most unfavourably impressed by the fact that although British newspapers told their readers all about the cut of his suit and even the color of his complexion, they reported nothing of the contents of the address brought by him from the Moscow Academy of Sciences to the University of Glasgow. Russian newspaper are certainly much more serious than ours. To us they seemed to be even more one-sided and to report only those facts which put the actions and motives of the West in the worst possible light.

NEED FOR FRANKNESS

In further pursuing the question of official interference with freedom of movement or of communication, I suggested to the scientists at the Academy that the best way of ensuring reciprocal good will was complete and friendly frankness and that we ought particularly to keep in touch with each other. They assured me that on their

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EDITOR'S NOTE—

The three articles on Russian science appearing in this issue continue the symposium which began in the February Bulletin. *Other articles on the same subject will appear in later issues.*

side there was no official interference with their correspondence, nor with their attendance at meetings; nor was there any customs interference with parcels to or from the Academy. I pointed out that when they did not come to congresses or answer letters, the natural inference in the West was that they were being prevented from doing so, and that this created doubts about the sincerity of their government when it talked peace.

Incidentally, I was asked at this Academy reception what Quakers had done to promote peace, which gave me the opportunity of telling them something of our three hundred-years' history of peacemaking. I can hardly imagine a similar question being asked at a meeting of the Royal Society, however difficult the political situation!

After the tea-party, at which unfortunately I talked too much to have any time to eat, I was shown around the Academy and presented with copies of Fedorov's *Symmetry and Structure of Crystals,* suitably inscribed, and with a translation of Newton's *Opticks.* These, with the books I received at the Institute, I have added to my library, but, alas, I cannot read them because they are in Russian; and why shouldn't they be? I am conscious of the fact that it is quite unreasonable to expect the scientists of a country of some 200 million people not to publish their work in their own language, even though most of us can't read it.

The only solution of the problem, apart from our learning Russian (and after all, one-third of the secondary school children in the USSR learn English), would seem to be duplicate publication or really detailed abstracts. It is not too easy, of course, for us even to get Soviet publications. Some are available only by exchange, and the receipt of these is very erratic. Some can be purchased, and the Society for Cultural Relations with the USSR does make translations of individual papers available to English scientists as far as they can, but the export of certain journals has been forbidden by the Soviet government. Whether this preceded or resulted from the similar ban imposed by the U.S. government, I do not know; from a scientific point of view both are deplorable.[1]

Even more serious than difficulties of language or of communications are the restrictions on scientific thought and theory recently imposed in the USSR by political and ideological arguments. The proceedings of the Moscow Conference on the Theory of Chemical Structure in Organic Chemistry (*Nature,* January 19 1952) makes depressing reading for those of us who are deeply concerned both for the freedom of science and for the breaking down of barriers of misunderstanding between Soviet scientists and ourselves.

My reaction was to read again the history of the controversy between Galileo and the church of his time, from his undertaking in 1616 not to "hold, reach, or defend" the pernicious astronomical opinions he had been expressing, to his publication in 1632 of the *Dialogo dei due massini sistemi del mondo* and his subsequent recantation before the Inquisition in 1633. We honor Galileo in spite of his forced recantations, and we realize that, taking a long view, the cause of truth has not, in spite of such setbacks, been injured by those who have the power temporarily to enforce their own views.

(*Continued on page 78*)

[1] Editor's note: See *Bulletin,* June 1951, pp. 162–63, for discussion of ban on export of American journals.

IV

SOVIET PSYCHOLOGY AND PSYCHIATRY

IVAN D. LONDON

Mr. London's paper was one of a group read at the symposium on Soviet Science held at the meetings of the American Association for the Advancement of Science in Philadelphia, December 27, 1951. Two of the symposium papers on Soviet genetics and mathematics were presented in the February issue of the Bulletin. *Mr. London's article has been slightly shortened and the documentation omitted. It will appear in a full volume soon to be published by the AAAS which will contain the text of the entire symposium.*

PSYCHOLOGY in the Soviet Union has, since 1936, been the stepchild of pedagogy, and a rather neglected stepchild at that. This strangely inverted relationship did not just happen; nor did it have an inner generation. It was decreed into existence by the Communist party.

In 1936 the Central Committee of the Communist party issued a decree abolishing pedology—a form of educational and child psychology. The abolition was prefaced with a recitation of pedological misdemeanors allegedly committed against the Soviet child who had been entrusted to the Soviet school for education into worthy membership of the future Communist state.

The chief accusation leveled against pedology was its reputed entertainment of the notion that the psyche is determined once and for all by an "irrevocable heredity and a somehow immutable environment." This would not do. Such a belief was inimical fundamentally to the Soviet state with its "vast perspectives for the future." It was thus anti-developmental; hence, anti-dialectical materialist. Man *can* transcend his heredity and *can* transform his environment—by fiat, it would seem, if necessary.

That there are to be discerned here echoes from the genetics uproar in the USSR is no accident. Behind-the-sceen motivations are similar, and certain continuities are deeply involved. However, this is not the place to surmise more or less on what these might be. The fact is that through them pedology came to be abolished as an independent discipline, and psychology was bid to serve the state's concept of education.

What manner of psychology survived the interferences of the party over the years, and what has been its development? After initial successes in the early twenties, the attempt of

reflexology[1] to substitute for it came to absolute nought by 1930. Varieties of behaviorism likewise were put aside at that time—quasi-officially. Reactology[2] had its demise with Kornilov's recantation and admission of error in 1931. After serious forays into psychological theory, the conditioned reflex retreated, for the most part, to the physiological confines in which it originated—confines so drawn in the Soviet Union as to include much of learning theory and a great deal of what we here would regard as physiological psychology.

But aside from ritualistic references to Pavlov, Soviet psychology became non-Pavlovian and took on a neofunctional aspect well exemplified in Rubenshtein's *Bases of General Psychology*, published in 1940 and designated as the official text for teachers and advanced students of psychology and education. As for Pavlovian influence therein, one may judge how much of it there really was from the fact that pages bearing any essential reference to Pavlovian theory did not number more than five in a book of near seven hundred pages of large size—an oversight on Rubinshtein's part which was seriously to embarrass him ten years later in 1950.[3]

Rubinshtein's book, which ably summarized Soviet psychology, such as it was in its reduced status as handmaiden to pedagogy, recevied the Stalin Prize in 1942. Yet this award did not save its second edition from harsh attack in 1947, when the ideological storm was breaking anew over a number of scientific disciplines in the USSR—this time with unmatched violence and ill promise for the future.

Apparently, it had been decided that Rubinshtein had deliberately ignored the psychology of the "new Soviet man" and that he was, moreover, a "servile fawner" upon the decadent theories of the bourgeois West. The requisite partisanship was absent from his work, and his style of writing rendered his book inaccessible to the wider audience of the masses. Evidently Soviet psychology, for which Rubinshtein had until now been spokesman, was in some sort of doghouse.

Two years later in 1949 the great celebrations of the hundredth anniversary of Pavlov's birth portended, for some, final calamity. Increasing numbers of prominent men in psychology, psychiatry, and physiology, representative of that wide group who generally play it safe, began to take out insurance against eventualities—this, in the form of a spate of allusions and references to the "great Pavlov" and in the revival of Pavlovian terminology and conceptions.

THE PAVLOVIAN SESSIONS

These men guessed right, for by the summer of 1950 the denouement was at hand. The USSR Academy of Sciences and the USSR Academy of Medical Sciences were called into joint session in order to discuss on a free, creative basis the "problems of the physiological theory of Academician I. P. Pavlov."

However, what the Soviets are pleased to call "free, creative discussion" frequently turns out to be discussion directed toward complete acceptance of those set in advance, especially when the proceedings are given full publicity in the scientific and public press. It is well always to keep this in mind.

In these Pavlovian sessions Bykov and Ivanov-Smolenskii were entrusted with setting the new line for psychology, physiology, psychiatry, and other disciplines. They were also given the task of detailing basic errors and singling out the chief transgressors.

The so-called discussion hailed the new line as a perspicacious wonder and heralded the lists of sins and sinners with abject amplification. Pavlov was re-enthroned and made co-equal with Michurin—a curious equation of a man of first magnitude with one of much lesser light. "Progressive materialist science" was declared triumphant by the event and "reactionary, idealist science" the loser. The bandwagon groaned with me-too-er's and the protesters of faithful past allegiance to Pavlov. Even Bykov was moved by the spectacle to public sneer; remarking, "Strange, how many Pavlovians we now have among us!"

If psychology had been a major discipline in the Soviet Union, the decreed retrogression to so-called Pavlovian principles would indeed have been catastrophic. However, since psychology is a discipline of little significance in the USSR, the major effect for a number of months following these Pavlovian sessions seems to have centered on frantic efforts to reconstitute psychology courses along Pavlovian lines and a busy detailing of the significance of the sessions for psychology and psychologists.

But the ensuing progress in the enforced reconstruction of psychology along Pavlovian lines was not deemed satisfactory. Accordingly, as is often the practice, in the February 5, 1951, issue of *Pravda*, in a paragraph toward the close of the editorial entitled, "The Creative Strentgh of Soviet Science," the suggestion was made that all perhaps was not quite well with psychology. "Why do psychology and pedagogy continue to this day so seriously to lag behind [the demands] of contemporary requirements? Why do [these disciplines] come forth with so few scientific publications? The workers in these important branches of science do not show activity in the research of vitally urgent questions. They enter into few creative discussions of scientific problems. Their criticism and self-criticism are on the weak side. [Furthermore], fundamental deficiences are to be found in the work of a whole series of institutes and scientific research institutions. . . ."

To Soviet readers who had long learned the importance and art of a daily careful between-the-lines reading of *Pravda*, the meaning was quite clear. Psychologists were to bestir themselves.

But in what manner? In public discussion, of course, and in the exercise of criticism and self-criticism; for had not that "mighty corypheus of science, great Stalin," intoned the "impossibility of scientific progress without the free clash of opinions irrespective of authority"?

Accordingly, Leont'ev, an active member of the Russian Academy of Pedagogical Sciences [RSFSR], dashed forth onto the pages of the February 28, 1951, *Teacher's Gazette* with some hasty talk about the in-

[1] The science of reflexes proposed by Bekhterev as a substitute for psychology. It interprets behavior as consisting of simple and complex reflexes.

[2] The science of reactions proposed by Kornilov as a substitute for psychology. It attempts a classification of behavior based on the rapidity of reactions and the inclination to greater or lesser energy-expenditure.

[3] See I. D. London, *Science* 114 (1951), 227.

compatibility of the method of self-observation with a strictly objective, materialist, progressive Pavlovian psychology. Leventuev replied that in Soviet hands the method of self-observation need not be idealist and that anyhow it all depended on the purpose for which the method was to be used. Gonobolin remarked that even Pavlov countenanced its employment as a first step prior to objective follow-up investigations.

The level of sophistication of these discussions may be judged from the following. Shardakov had ventured the opinion that the development of man's psyche could be understood in a variety of circumstances through simple study of its interaction with the surrounding environment. Gonobolin pronounced this an idealist approach to the psyche, because the psyche, as Shardakov would treat it, was not at all times related to events in the cerebral cortex in accordance with Pavlovian laws of higher nervous activity. In other words, Gonobolin avers the impossibility of any valid approach to the psyche or, better, man's psychology in general that is not point by point physiologically referable to the cerebral cortex. This is as if to say that in physics Boyle's law, inversely associating volume and pressure of a gas at constant temperature, is an inadmissible idealist formulation merely because it does not directly refer back to the molecules constituting the gas. One wonders what personality theory would have to look like to make it accord with so-called Pavlovian prescription. Since there is little of such theory in the USSR, that is one less immediate worry for the harried Soviet psychologist.

PRESENT STATE OF SOVIET PSYCHOLOGY

A year and a half have passed since the Pavlovian sessions. Fulminations continue, but where there was once sterility, there is still sterility. If anything, the scene is even a little more bleak than before, since perplexed psychologists—and there is plenty of evidence of bewilderment—shrink from committing themselves in print.

While at least a year or two should be allowed in order to discover through published sources what is now being done, there is little reason to anticipate significant changes. Psychology is at present a nearly impotent discipline, and it is hard to conceive of its speedy recovery. Kosichev, for example, in the September 18, 1951, *Literary Gazette*, belabors the widespread practice of armchair psychology, which passes currently for the psychology of the "new Soviet man," and calls for an experimentally based psychology whose practitioners, through work in the laboratory, know the meaning and feel of psychophysiological experiment. He deplores the fact that, at the Moscow State University, the Soviet Union's leading institution of higher learning and one of its very few psychological centers, there are only twenty graduate students of any kind in psychology—an indication of the dearth of highly qualified personnel without which no program, whether sponsored by the party or not, can succeed.

A DEVIATION FROM THE PATTERN

The ideological meddling with the sciences and the pattern of political interference and direct control which were clearly revealed during the course of the genetics controversy in the USSR are re-exemplified in Soviet psychology. There is no denying this.

But the complete picture must take account of deviations from this pattern which surely exist, because no society, however rigid, is without complexity. Nothing is more dangerous than blithely to ascribe a monolithic character to all aspects of the Soviet scene, merely because we describe the Soviet Union as totalitarian. The dominance of a given pattern in the control of the sciences does not preclude variation in it, nor does it deny an occasional *modus vivendi* of different character to some particular discipline or branch of science.

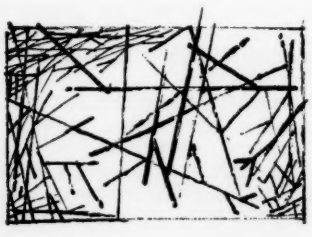
For example, in Soviet physiological psychology, there is a field of special endeavor involving research on sensory interaction[4] in which there has been research of apparently high caliber.

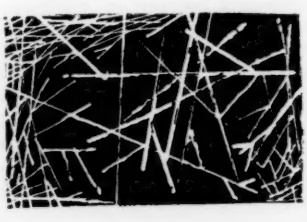
Acquaintance with Soviet research on sensory interaction would allow one, on first blush, to make a case for its ideological *raison d'être*, for by the mid-thirties a theory of Lenin's in which the psyche is conceived as reflecting an objectively existing outer world independent of man's consciousness, had come to be widely propagandized in scientific circles. The available evidence seems to indicate that during the twenties relatively little attention was devoted to sensation and perception in general in the Soviet Union; while after the appearance of Lenin's *Philosophical Notebooks*, first published posthumously in 1929–30, sensation and perception gained public importance since they were regarded as centrally involved in Lenin's epistemological theory.

Research in these fields increased in ostensible response to ideological pressure, indirect as this pressure may have been. In 1941 an independent journal, *Problems of Physiological Optics* (*Problemy Fiziologicheskoi Optiki*) was founded, and in 1950, *Problems of Physiological Acoustics* (*Problemy Fiziologicheskoi Akustiki*). In 1950 the fourth edition of Kravkov's notable text, *The Eye and Its Function*, appeared after first and third editions in 1932 and 1945, respectively. Investigations in sensory interaction were a continuing central consideration.

On the surface, such research would seem not only to be motivated by Leninist theory, but to accord well with dialectical materialist views on the wholeness of the organism and the mutual interaction of its parts. In addition, it was obviously "materially" based, as the Soviets are pleased to understand the word, and it had practical significance, thereby exemplifying the Marxian "unity of theory and practice."

Now, as far as one can make out on the basis of the available literature, both scientific and popular, workers in the field of sensory interaction have been singularly free of the kind of interference we have grown accustomed to see elsewhere. At first glance, it would seem that this should occasion no surprise since the type of problem is such as naturally to make





[4] Research on sensory interaction investigates, as a rule, the response of one sense organ under primary stimulation as a function of accessory stimulation of another.

it and its treatment dialectically appropriate. So it would seem. In other words, research in sensory interaction managed to lead a charmed life, either because it was ideologically favored or because it was inoffensive.

If we want always to believe the worst about the Soviet Union, we will be satisfied with this explanation. It is obvious; it jibes with the over-all pattern; and it builds an enticing consistency. Perhaps it was a factor. Probably so. Nevertheless, the facts suggest that the factor, even if operative, may have been quite secondary.

Serious Russian research in sensory interatcion can be traced back to 1918 when Lazarev performed his experiments on the "mutual influence of the visual and auditory organs." Kravkov, the foremost psychophysiologist in the field, was already publishing in foreign journals in the early thirties before Lenin's theory began to take hold in scientific circles.

Then what about the years afterwards? One definitely emerges from a consideration of the literature with the feeling that the rash of articles on sensory interaction which appeared in Soviet journals throughout the thirties and forties were of a kind that owed their origin more to previous work and thought than to ideological theory. Lenin's theory seems really not to have had anything to do with either the choice of problems or the direction of research. At every stage, except for wartime demands, considerations, autonomous to sensory interaction, seem to have, in the main, dictated the sequence and kind of research problems undertaken.

This situation may be said now to have been changed, however, if practice should follow announced intention. The 1950 volume of *Problems of Physiological Optics* has pointed out to its contributors the significance of the Pavlovian sessions and has instructed them to take due notice of the dominant role of the cerebral cortex, a cardinal point of official Pavlovian theory. Occasional references to Russian priority in research on sensory interaction are also now to be encountered—a practice inspired by the party command to exalt "native science." It will be interesting to see what changes, if any, take place in research on sensory interaction as a result of the expansion of party sovereignty over the sciences.

The Pavlovian sessions were quite serious in their consequences for psychiatry, at least for theoretical psychiatry. What the consequences will prove to be in practice still awaits future telling, although some surmises can be made even now.

In comparison with psychology, psychiatry is a major discipline, primarily because of its close association with medicine and because of its practical value. The psychiatry of the Soviet Union, with some exceptions, has for a number of years been quite conservative and is medically oriented, although there is a "materialist" psychosomatics termed "cortico-visceral pathology."[5]

Although Pavlov was greatly interested in psychiatric problems and made his contributions even here, after Pavlov's death in 1936 there was as little Pavlovian psychiatry in general acceptance and practice as there was Pavlovian psychology. This, of course, did not preclude the usual declarations of indebtedness to Pavlovian principles, nor the liberal sprinkling of psychiatric literature with inessential allusions to Pavlovian theory. As a matter of fact, several prominent psychiatrists, such as Shmar'ian and Gurevich, did not hesitate frankly to call Pavlovian conceptions and theory a menace to Soviet psychiatry as long ago as 1936.

Pavlovian psychiatric techniques center on sleep and suggestive therapies. These, however, have had a restricted applications. Since the Pavlovian sessions, they have been underscored as necessary to the practice of Soviet psychiatry. But in view of the great shortage of trained personnel, both professional and technical, the space inadequacies and lack of necessary drugs in Soviet psychiatric hospitals (in 1949 many were without sodium amytal), there is likely to be no increase in the use of genuine sleep therapy until these deficiencies are remedied.

An estimate of the problems facing the practical application of Pavlov's principles to Soviet psychiatry can be gained by considering the therapeutic situation in the Soviet Union in 1949—the last year for which we have reliable data.

If therapy is applied, it is of the following four types: physiotherapy, work therapy, psychotherapy, and active therapy—the latter comprising those methods which employ chemical, electrical, and surgical treatment.

Outside of institutions reserved for the "elite," the first three are little practiced in spite of credulous talk about the wonders of Soviet work therapy. The real reasons for this have a familiar ring: lack of qualified personnel, lack of necessary equipment and materials, overcrowding, the general expense, and so forth. *Banshchikov and Rapoport* even allude to the lack of "first-rate manuals" for the low estate of psychotherapy.

The major emphasis is on active therapy. In 1949 insulin shock therapy was administered twice as often as electroconvulsive therapy, and the former is gaining steadily, especially as insulin shock therapy is declared compatible with Pavlovian conceptions. These two therapies comprised most of the cases of active therapy reported.

Sulphotherapy, particularly in the form of sulphozene with its heightening of temperature, has been applied to some cases of schizophrenia of long standing, and success comparable to that of insulin shock therapy on cases of lesser standing has been widely claimed for it. Less than 6 per cent of the patients treated by active therapy in Russia (RSFSR) during 1949 underwent therapy by sleep. Even this small percentage included a majority of cases that could not be said to have approximated physiological sleep; for example, a deep narcosis with serious toxic effects may have been substituted in its stead. As for leucotomy,[6] it was officially banned in 1950 as being "anti-Pavlovian," "anti-psychiatric," and "contrary to the humanist traditions of Soviet medicine."

This brief sketch of psychiatric practice in the Soviet Union is indicative of the obstacles to be overcome before Soviet psychiatry can be said to be Pavlovian in practice. The lot of the theorist who is commanded to draw up a Pavlovian psychiatry is a most unhappy one. It remains to be seen whether the conversion will be more than ritualistic and terminological. After all, Soviet psychiatrists are interested in curing their mentally ill as well as upholding a prescribed theory. How they propose to manage both is their big problem. In view of the difficulties, one is tempted to make for Soviet psychiatry the same prognosis as for Soviet psychology—negative.

[5] The mind-body unity postulated by psychosomatics is reflected in "cortico-visceral," the mind being set in the cortex and the body in the viscera. American psychosomatics is considered "idealist" and "perverted."

[6] A brain operation which severs nervous connections between the frontal cortex and the thalamus and which is employed usually as a last resort in the treatment of certain psychoses.

V

SCIENCE AND SCIENTISTS IN RUSSIA

EUGENE RABINOWITCH

THE state of science and the situation of scientists in Russia is one of the most contradictory aspects of the Soviet picture. It is impossible to describe it without admitting that things exist side by side that seem mutually exclusive.

SOVIET SCIENCE—FLOWERING OR BLIGHT?

In American public opinion, there is much misunderstanding of Russian science. The belief is widespread that science had hardly existed in Russia before the Revolution and that Soviet science is a child of the Soviet regime.

Related to this is the belief that Soviet science is second-rate, and that whatever technical achievements—such as the rapid building of an atomic bomb, or the construction of superior jet planes—have been demonstrated by Soviet technology, must have been the work of captured German or renegade Western scientists.

Not so long ago, newspapers carried a story about Gustav Hertz, a German Nobel Prize winner, known to have been taken to Russia after the fall of Berlin. This physicist, the story ran, was not dead (as earlier rumors had it) but was working in a secret, luxurious laboratory built specially for him in the Caucasus; it was due to his work that the Soviet Union was able to produce an atomic bomb so quickly.

An alternative (and even more widely believed) version of the Soviet acquisition of the atomic bomb is that its "secret" was "stolen" from America by May, Fuchs, Greenglass, and other traitors. In this way, a smug satisfaction with our own superiority is fostered—a belief that we can leave Soviet competition far behind simply by tightening secrecy and preventing "leaks."

The truth is that Russian science has a two-hundred-year-old tradition of high achievement. If its successes cannot compare in number and variety with those of German, French, or English science, they are superior to those which American science could claim prior to the First, if not to the Second, World War. They began with Lomonosov's enunciation of the principle of conservation of energy in 1747 (a century ahead of Meyer and Helmholtz!) and continued through Lobachevsky's discovery of non-Euclidean geometry in 1826, and Mendelyeev's establishment of the periodic system of chemical elements in 1871, to mention but two highlights. Biology owes to Russian science the discovery of viruses; agriculture, the creation of soil science, and so on.

While many of the recent claims of Russian "firsts" are either baseless or vastly exaggerated, it *is* true that Popov used electric waves for the transmission of messages before Marconi, and that Yablochkov's incandescent lamps preceded those of Edison by several years. Well known to specialists are the achievements of pre-Revolutionary Russian science in mathematics[1] and its applications—including the militarily significant fields of hydro- and aerodynamics, and ballistics.

Committed to rapid industrialization of the country, the Soviet government gave to Russian science what it lacked before—unstinting material support and national prestige. Under this powerful encouragement, Soviet science grew in leaps and bounds, expanding in many new directions, both practical and theoretical. Innumerable new research institutes were established and liberally supported. Pioneer technical developments—for example, in the production of artificial rubber, or in underground gasification of coal—showed that in some fields, at least, Soviet technology went far beyond mere "catching up" with America or Western Europe. Outstanding advances have been made in pure mathematics (Kholmogorov, Vinogradov, Gelfand), and in several other fields of basic research, for example, the kinetics of chemical reactions (Semenov), colloidal chemistry (Frumkin), and "ferroelectricity" (Joffe).

Because of the Soviet insistence on maximum speed, the *average* level of research work in many universities and research institutions has been for a time—and, in part, still is—rather low; too many people of insufficient education or inferior intelligence have been suddenly converted into scientific investigators or science professors. But this situation shows all the signs of being temporary. As the second generation of Soviet scientists follows the first, the average quality of scientific production is clearly on the upgrade; while its quantity has snowballed.

Since the end of the Civil War, the most brilliant and independent minds among the younger generation in the Soviet Union have been attracted to science. Not only was the career of a scientist economically more attractive than almost every other career in the Soviet Union, but—what was even more important—science was the only field in which a man could enjoy intellectual freedom, choose his own subject of inquiry, think for himself, and communicate with those of similar interests all over the world. The dominating political and economic doctrine had put humanities into a straitjacket; soon its dead hand came to bear also upon creative writing and art; but natural science remained an oasis of intellectual freedom. In the first twenty years of the Soviet system, a Soviet scientist could work freely in his field of interest, print his results, without censorship, in scientific journals at home or abroad, and consort with visiting foreign scientists; he could look forward to a trip abroad—something of which other Soviet citizens could not even dream—perhaps even to a leave of absence for a year or two, to be spent in the laboratory of a

[1] J. R. Kline, "Soviet Mathematics," *Bulletin*, VIII (February 1952), 44–47.

famous colleague in England or Germany. Outstanding foreign scientists reciprocated by coming to teach and work in Soviet Russia. Visits by foreign geneticists, such as H. J. Muller and R. Goldschmidt, stimulated, in the twenties, a spectacular spurt of genetics in the Soviet Union.

Attempts to impose dogmatic restrictions on science were not entirely absent even in this "golden age" of Soviet science. Certain physical theories, including relativity and quantum mechanics, were sporadically attacked by party philosophers; but in vain did these critics invoke Marx and dialectical materialism—political leaders were loath to frighten the hen they expected to lay many golden eggs.

From the very beginning, the ideological forays into the field of biology were more ominous, since these were supported by an influential group *within* Russian biology itself—men such as Timiriazev, a distinguished plant physiologist, but a doctrinaire philosopher who saw in an antiquated interpretation of Darwin's theory the basis of a Marxist system of natural science. Because of the influence of this school, many biological disciplines in the Soviet Union failed to show, after the Revolution, the same rapid growth as occurred in mathematics, physics, and chemistry. The Soviet developments in biology went into breadth more than into depth, into collecting observations and cataloguing species more than into new fundamental studies.

One case in which Soviet biology did pioneering work was N. Vavilov's research on the origin of cultivated plants. Vavilov was supported by Lenin; but after Lenin's death, his opponents, the self-styled "Michurinist" biologists, succeeded in getting the ear of the political bosses. Vavilov's demotion from the presidency of the Soviet Academies of Agriculture, 1933 marked a turning point in the history of science in the Soviet Union. From there on, it suffered a series of hard blows. The most spectacular was the destruction of Russian genetics. Vavilov, the most prominent of Russian geneticists, was arrested in 1941 and exiled to Northeastern Siberia, where he died. In the 1948 session of the Soviet Academies of Agriculture, Vavilov's opponent, Lysenko, announced that his archaic concepts of inheritance had been sanctioned by the Central Committee of the Communist party; scientific genetics in Russia was effectively silenced by this one sentence.

The debacle of genetics has been discussed and documented in the May 1949 issue of the *Bulletin*. Its reverberations in other fields of biology and medicine, and the subsequent "purges" in Soviet chemistry and physics, are described in a series of articles currently appearing in the *Bulletin*.

When the news of violent Soviet intervention into the free development of Russian science spread abroad, people began to ask: What does this violent intervention of political power and philosophical dogma in scientific thought portend for the technological progress of the Soviet Union? Many have jumped to the conclusion that Russian science is being effectively destroyed by the Soviet bureaucracy, and that a decline of technology is bound to follow. It is argued that once the sap of free thought has stopped flowing through the tree of science, even its branches not subjected to the axe will wither and die. Those for whom Soviet science is primarily a dangerous adjunct of Soviet military might, gleefully anticipate a decline in the military technology of the Soviet Empire.

However, much of this is wishful thinking. Undoubtedly, intellectual freedom provides the most favorable atmosphere for the advancement of science, but some of the greatest scientific discoveries in history have been made, and some of the most revolutionary ideas conceived, under absolutist regimes lending secular power to the defense of anti-scientific church dogmas. The restrictions on freedom of science will not cause the brighter minds in the Soviet Union to choose other fields where pressure is less stifling—for the simple reason that no such fields exist. Certain areas of science may be shunned or altogether abandoned for a while; but scientists who would have contributed to their progress probably will turn their attention to other fields of research, rather than quit science altogether. For some time, at least, the main effect of the ideological pressure may be to push more academic scientists into practical work, where all achievement is likely to be appreciated with no questions about ideology asked.

In reading reports on the activities of the Soviet Academy of Sciences, printed in its *Vestnik* (*Herald*), one sees blight spreading over certain areas of science, but notices that other, often closely related, areas have remained unaffected. The reports abound in denunciations of various research institutes or individual scientists for lack of ideological reliability. A biological research institute in Eastern Siberia may be reprimanded for not having taken to heart the pronouncements of Comrade Stalin on linguistics; a writer on science, for quoting foreign sources too often and domestic ones too rarely. Whole institutes are closed for reorganization; books are ordered re-written; individuals are instructed to exercise "self-criticism"—or else. . . . But between admonitions and sanctions directed at deviationists from the party line (or at those who have failed to guess what zigzag the line will take next), we find long pages describing sound and impressive progress.

★ ★

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★ ★

Walter Gellhorn Receives The Hyman Goldsmith Memorial Award

The *Bulletin* takes pleasure in announcing the first presentation of the Award given in honor of one of its founders, Hyman H. Goldsmith, who died in August 1949.

The prize of $200 goes to Walter Gellhorn, Professor of Law at Columbia University, for his book, *Security, Loyalty, and Science,* published by Cornell University Press in 1950.

At the time of Mr. Goldsmith's death it was decided that a fitting commemoration would be an annual award for the best article, book, or public pronouncement which contributes to the clarification of the right relations between science and politics—a problem in which Mr. Goldsmith had the greatest interest.

In the opinion of the Committee of Award, Mr. Gellhorn's book best fulfils this criteria for the year 1950.

Mr. Gellhorn's study is an appraisal of the administration of United States security policies and their impact on American science. It treats particularly the problems of secrecy in the field of atomic energy.

The Committee of Award included Samuel K. Allison, director of the Institute for Nuclear Studies; Cyril S. Smith, director of the Institute for the Study of Metals, both of the University of Chicago; and Clifton Utley, the radio commentator.

The *Bulletin* thanks all who have helped by making nominations or sending contributions for the award.

Announcement of the date and conditions for the second award will follow in the next issue.

One is left with the impression of a flourishing community stricken by an epidemic. Here and there, houses are closed and quarantined. Nobody knows for certain how to protect himself from the scourge. A certain ritual of pacifying the angry gods is followed. It includes praising their wisdom at the beginning and end of each printed or spoken communication, and loudly denouncing all those stricken by the plague as sinners who have brought it upon themselves; but even the strictest adherence to this ritual does not guarantee immunity. However, as men do in real epidemics—as they did during the war under the bombs—those who are still hale, go to work as usual. They tend their fields as lovingly as ever, hoping that sickness will spare them, and that no bomb will fall on *their* barn after they have gathered the crop.

It is wrong to think of contemporary Soviet science as being largely paralyzed by the ideological dictatorship of ignorant politicians. Some branches may be dead or stunted, but it is still a vigorous, growing tree. Limbs that have been cut off sprout new shoots; those prevented from growing in their natural direction, grow around the obstacle. Even in areas that have been seemingly completely devastated, such as genetics, quiet behind-the-scene activity probably continues. If the pressure is released, or transferred elsewhere, new growth may suddenly appear where at present, all seems dead.

SOVIET SCIENTISTS—FRIENDS OR FOES?

Miss Kathleen Lonsdale, a distinguished British crystallographer, recently visited Soviet Russia with a delegation of Quakers. She had several meetings with Soviet scientists and found them well informed, eager for communication with their colleagues abroad, and critical of the British and American governments for obstructing the travel of Soviet scientists to international meetings.[2]

In an article in the (British) *Atomic Scientists News,*[3] Miss Lonsdale said that according to her impressions, Russian scientists (and Russians in general) are well satisfied with the political system existing in the USSR. Since Russians have had no experience in political and personal freedom, she suggested they do not resent its absence. This explanation of the apparent lack of political opposition in the Soviet Union can be found in many reports of visitors to Russia; but it is contradicted by the whole history of Russian intellectual life.[4] Not only Russian literature, but Russian science as well, has been closely associated with the fight for political emancipation of the Russian people. Russian scientists have always maintained a lively interest in political and intellectual freedom, as contrasted to the political disinterestedness so common among German scientists before Hitler. Practically every Russian scientist of the past, including such conservatives as Mendelyeev, has at some time risked his whole career by identifying himself with the struggle for freedom.

Those who have enjoyed personal association with Russian scientists in recent years will testify that the tradition of political liberalism, belief in the absolute value of scientific truth, and allegiance to the international community of scientists is not dead among them. This applies not only to the older pre-Revolutionary generation (which, incidentally, still dominates the Russian scientific stage), but also to many of the younger scientists.

As long as the Soviet rulers did not interfere with the freedom of scientific

[2] See page 66 of this issue: "Impressions from a Recent Moscow Visit," by Kathleen Lonsdale.

[3] "A Quaker Scientist Visits the Moscow Academy of Sciences," *Atomic Scientists' News,* I (November 1951), 50–54.

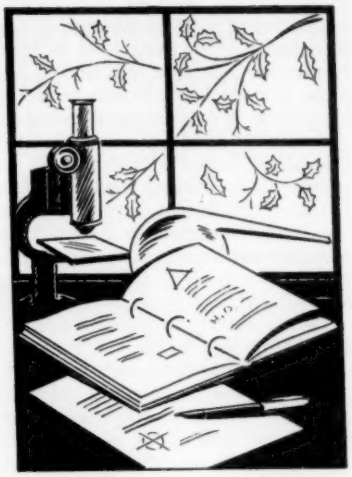
[4] This was discussed by Mr. L. Volin in a paper "Scientific Inquiry and Intellectual Freedom in Russia (1850–1950)" at the December 1951 meeting of the American Association for the Advancement of Science.

inquiry, one could believe that Russian scientists found ample compensation for the loss of political freedoms in the vast possibilities of true and fruitful work opened to them by the Soviet encouragement of science. In recent years, however, the ideological offensive has invaded science itself, and physicists and biologists have been deprived of freedom of opinion, not only on political questions but also on quantum theory and genetics.

The apparent lack of opposition to this denial of free scientific thought allows of no explanation in terms of the supposed Russian indifference to political freedoms. Unless it is suggested that Russian scientists are also peculiarly lacking in scientific integrity, their meek acceptance of dictation in this field closest to the conscience of a scientist, is evidence of a pressure so relentless as to destroy all capacity to resist, even when man's deepest convictions are involved.

Speeches and writings of prominent Soviet scientists have been quoted, proclaiming their wholehearted support of those parts of the present communist dogma which reject the freedom of opinion in scientific matters, and insist on acceptance of officially endorsed theories, even if these are contradicted by unbiased experimen*s*—the only valid test of a theory in the eyes of a scientist. Official pronouncements of the Soviet Academy of Sciences—the highest scientific authority in Russia—supporting such unscientific teachings and condemning their opponents, have caused consternation among Western scientists. Some of them resigned from the Soviet Academy and angrily denounced their Russian colleagues, over whose signatures such statements had been issued, as traitors to the spirit of science.

How is it to be explained that Russian scientists—including some that are widely known and respected—not only do not protest the anti-scientific trends of Soviet policy, but seemingly endorse them with enthusiasm? The analogy with the strange behaviour of accused persons in Soviet political trials comes to mind. However, no torture or long solitary confinement can be cited as a reason why reputable Russian professors visiting New York go out of their way to praise Lysenko's "new biology." Neither can scientists—whose traditional intellectual atmosphere has been that of free thought and tolerance—be credited with the psychology of political conspirators, who have spent their life serving a fanatical political party, and who



maintain their loyalty to this party even when it demands from them the ultimate sacrifice of self-debasement, and promises in exchange nothing but death and ignominy.

The fact is that the training of population in automatic conformity has reached, after thirty years under a modern totalitarian system, such perfection that no special group psychology and no individual intimidation are needed for each citizen to behave like a soldier on parade.

In describing her conversations with Soviet scientists, Miss Lonsdale didn't mention whether she asked how they felt about the suppression of genetics, the abolition of resonance theory in chemistry, and other examples of Soviet interference with the freedom of scientific inquiry. Since she was on a mission of good will, she probably thought it better not to broach the subject. There, is however, little doubt that had she asked such questions, she would have come back with the report that Soviet scientists fully support these policies of their government and are grateful to the Communist party for helping them to avoid ideological pitfalls. Miss Lonsdale probably would have been able to report that such answers were given to her quite spontaneously, in the absence of any official witnesses, and therefore must represent the true convictions of Russian scientists.

Those who have never lived under an all-pervading totalitarian dictatorship cannot comprehend that even when no potential informer is present, a Soviet citizen—be he a man in the street or the president of the Academy of Sciences—feels prevented from telling anybody who is not his close friend, and especially a foreigner, *anything* but what he thinks he is supposed to tell. This is done automatically, as a kind of self-preservation reflex. You have to know a Soviet citizen for a long time and establish a relation of personal trust before you can hope to get an inkling of his true convictions. This was so even in the late twenties when the ideological pressure was far lighter than now, and many Soviet scientists came abroad to study or to do research in European laboratories.

I remember with some amusement the case of a young Englishman who used to argue with me about the state of affairs in Russia. The authority he quoted was a prominent Soviet physicist, then working in Cambridge. The accounts of the latter had made the English student a great enthusiast for the Soviet system; my information was obviously obsolete and second-hand compared to his. Two years later, the same Soviet physicist again came to Europe, but this time the Soviet government slipped up by permitting his wife to accompany him. On the first day of his arrival, he made no secret of his intention never to return to Russia—and he never did. I sometimes wonder whether he went to the trouble of "unindoctrinating" his English friend!

Among the Soviet scientists who used to visit Europe before the war, one of the "regulars" was the physicist, S. I. Vavilov, younger brother of the then already famous geneticist. Vavilov's European friends remember him not only as a good scientist, a man of forthright character, great personal charm and broad cultural interests, but also as a good European liberal, devoted to freedom of thought and deeply believing in the universal value of scientific truth. His attitude toward the totalitarian system in power in Russia was one of complete and bitter opposition. It had remained so five years later when I saw him for the last time. Soon after that, his famous brother was first attacked by Lysenko—an attack that was soon to lead to his demotion, arrest, and death in exile. It is hard to believe that the tragic fate of his brother has transformed Vavilov's critical attitude toward the Soviet dictatorship into one of admiration; yet, in the same year as the older Vavilov disappeared, the younger Vavilov was elected the president of the Soviet Academy of Sciences. German armies were then overrunning Russia.

In common with the majority of

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SOVIET SCIENCE

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non-communist Russians, Vavilov must have felt it his duty to help repulse the German aggression and prevent the destruction and degradation which threatened Russia and its civilization if Hitler had been victorious. He probably also thought that as president of the Soviet Academy, he would be in a position to protect Russian science from the influence of incompetent party hacks.

Six years later, Vavilov, as president of the Academy, had to accept responsibility for disciplining the enemies of Lysenko; for closing research institutes whose work Lysenko denounced and ordering the rewriting of textbooks that presented the scientific theories of inheritance in preference to Lysenko's quack teachings. He gave speeches in praise of the new Soviet biology, published books on dialectical materialism in science, and even wrote (or signed?) a book on Stalin as a scientist. After his death a year ago, at the age of sixty, he was praised by the Soviet press as a "great Soviet patriot." He never joined the Communist party.

There is not the slightest doubt that in Vavilov's eyes, Lysenko was an impostor, while the geneticists whom he disciplined were good scientists and—in all probability—his personal friends. I doubt whether he believed in what he wrote in praise of dialectical materialism, as the basis of true science. Having known him well, I cannot believe that he had become reconciled to political dictatorship and suppression of the freedom of thought. Neither do I believe that he had become a cynical opportunist, enjoying his position of prominence as president of the Soviet Academy, member of the Council of Soviet Ministers, and recipient of the highest Soviet awards. Rather, I think that he had become hopelessly enmeshed in a web from which he could not escape; that he still believed—or tried to believe—that by remaining in his position he could ward off worse threats to Russian science; and that he saw, in the vast constructive activities of the Academy for the advancement of the economy and technology of Russia, a compensation for the life of continuous dissimulation and sacrifice of innermost convictions, to which his position condemned him.

It seems that after years of this kind of schizophrenic life, many Russians have acquired a sort of immunity to it, and may be suffering under it less than would a European or American suddenly placed in a similar position. Praising Stalin as the greatest scientist of our era, or denouncing Pauling's theory of chemical valence as "bourgeois pseudo-science" is, for them, merely a matter of mechanically performed obeisance. Yet, I cannot imagine that they do not suffer when they see the work of their respected colleagues destroyed, or their friends subjected to arrest or deportation—if not a worse fate—for no other crime than that of following scientific truth as they see it.

I am sure that the Soviet scientists with whom Miss Lonsdale talked were very well aware of *who* is responsible for the disruption of scientific ties between Russia and the West. After all, it is *they* who have been prohibited—in effect—not only from corresponding but even from exchanging reprints, with their colleagues abroad. *They* have been treated to movies and dramas showing the wickedness of American and English scientists, and the danger of treating them as friends or equals. I am sure they do not believe this propaganda, and are as eager as the scientists in Europe and America for the resumption of international communications. They jump at every occasion when they can express their true feelings without offending the powers that be. (We have only to recall the speech of Kapitza at the Academy celebration in 1945, proclaiming the unity of world science, or the article by Mandelstam printed this summer in the Moscow *News*.)

One can understand that, not being able to utter a word of criticism of their own government—which they know to be primarily responsible for the severing of international ties in science—they find a measure of satisfaction in attacking the acts of the British and American authorities that indicate a similar isolationist trend. They feel—and rightly—that any Western "reprisals" to Soviet restrictions of international communications are only likely to make the Soviet attitude still more intransigent.

MOSCOW VISIT

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The really important thing is that Soviet scientists should continue to experiment honestly, and faithfully to report the results of their experiments. They do feel alienated from scientists in the West, and this must make it all the more difficult for them to stand firm against those who use political pressure to enforce scientific conformity. If at any time we are tempted to feel righteous indignation or moral superiority, let us rather humbly remember that secrecy is also contrary to a true scientific attitude, and yet many of us have acquiesced in it, not for scientific but for political reasons.

I did not discuss in detail the question of the international control of atomic energy, although I was often called upon to justify my refusal to support the Stockholm Peace Appeal. It seems to the people of the USSR so *obvious* that the purpose of the stockpile of atomic bombs and the erection of atomic bases was and is to make the governments of the West strong enough to launch an attack on the USSR and to destroy a social structure which is feared and disliked. *Collier's* magazine for October 27, 1951, would not, I think, convince them of the contrary, even if they read every word of it, including the subtitle. Nor would Mr. Gross' contemptuous dismissal of the recent Russian proposals as "double-talk without meaning," or Mr. Acheson's subsequent comments in the same vein. Those of us who live on what has been cynically called "the USA's unsinkable aircraft carrier" may perhaps be forgiven if we take more than an academic interest in the wider problems of reconciliation between East and West, and deplore this rigid attitude.

In some ways the Soviet Union is passing through a historical stage that we have outgrown, and historical processes cannot so easily be by-passed. If international communications between East and West are ever to improve, it will need continued patience and understanding on *our* part. If they are in the wrong, it will be all the more difficult for them to make the first overtures; and we must realize that, from their point of view, right is *not* all on our side. Above all, we must refrain from condoning in ourselves any expression of the temper and practices that we condemn in others.

TACTICAL ATOMIC WEAPONS AND THE PROBLEM OF ULTIMATE CONTROL

DAVID R. INGLIS

This article, like that of Dr. Cavers elsewhere in this issue, well illustrates the thesis that up-to-date understanding of atomic technology is essential to forming intelligent conclusions on disarmament control policies today. Dr. Inglis worked at Los Alamos, New Mexico, during the war, and is now on the staff of Argonne National Laboratory.

IT HAS recently been reported that tactical uses of atomic weapons are an immediate possibility, that "small" atomic bombs or perhaps even artillery missiles exist, and very soon wil be available in sufficient numbers for effective use on the battlefield against troop concentrations and other localized military objectives. The impression given to the newspaper reader is that tactical atomic bombs are really small, some perhaps just a little more powerful than a large conventional high explosive bomb. In connection with recent Nevada experimental tests (perhaps because distant observers confused "laboratory" experiments with tests of actual bombs) the figure twenty tons TNT equivalent was prominently mentioned, which is only twice as much as a 1944 blockbuster.

To these reports the public has reacted with a sigh of relief, feeling that now one will not have to worry about the numerical superiority of the Red army, and military commentators have more accurately pointed out that it contributes enormously to the problem of protecting a strong defense line against massed break-through. To the extent to which a defending army, whether alerted or not, may be assumed to be continuously protected by field fortifications, or to be widely dispersed and still effective through mobility, the field use of atomic bombs may be considered to be less of an advantage in opening the way for an attack than in dispersing spearheads massed for attack, and thus a stabilizing influence on the military situation. Thus the short-range considerations of the defense of Europe, and perhaps also of South Korea, seem to dictate immediate emphasis on the tactical use of atomic weapons, and the short-range prospects appear to be brightened by the possibility of placing at least partial reliance on these weapons.

In the long-range view however, the news of tactical applications of atomic explosives is not good news. Even in the moderately short-range view, looking just a few years beyond the year 1954 toward which our present armament goals are aimed, it is not pleasant to contemplate the probable use of atomic field weapons by an enemy on the offense to counterbalance our use of them on the defense. Though the possibility of sticking to foxholes does favor the defense, probably the main change in ground fighting will be the greater ease of human slaughter, an intensification of the chaotic carnage of battle. The impression is almost surely false that tactical atomic weapons will efficiently and effectively fill the gap between ordinary high explosive bombs and "full size" atomic bombs, making a continuous graduation in explosive power from one to the other (which would imply to some people that there is no essential difference between the two.)

The atomic bomb in its "strategic" use remains just as much as ever a horrible threat to the cities of the world. The tactical atom does not greatly reduce the temptation of atomic surprise attack. We must still remember Pearl Harbor, and the possibility of a repetition with a hundred times the scope. We must remember that wars in the past have been started when the peoples of neither side really wanted war, through errors in judgment and overconfidence in the effectiveness of the first push. This sort of confidence is much easier now with the prospect of destruction on the atomic power scale. It takes only one fool in power to unleash an unprecedented holocaust.

In the long run, the essential new feature of the atomic age remains the strategic threat, and it is difficult to foresee just how we can prevent it from bringing an end to civilization as we know and treasure it. Each of us fosters an irrational hope that, in spite of all the martial portents, some unforeseeable development will intervene and bring to an end the growing instability, or that this time, at long last, the price being so great, the opposing factions of the world will sagely refrain from war as a method of settling their disputes. But it seems like expecting two wrestlers balanced on top of a high and narrow fence to spar eternally, trying to come to grips without pushing each other off. Basically in the long run, by providing a colossal weapon for surprise attack, atomic energy remains a powerful new unsettling influence in a world where the peace has not been particularly stable in the past.

NEED FOR LONG-RANGE PLANNING

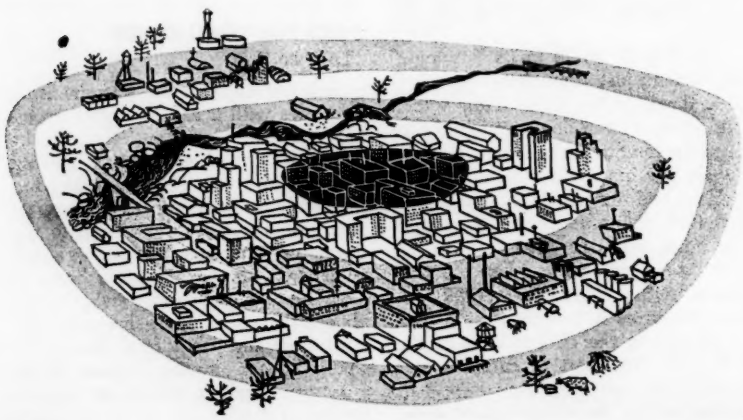
Political life and the statesmanship that goes with it are, of urgent necessity, occupied almost entirely with the need for short-range planning, looking just past the new election or the immediately discernible threat of aggression, opportunistically reacting to the developing situation. This comes about partly from the essential selfishness of most human motivation (why worry about what is going to happen after our time?) and partly from the impossibility of making wise decisions about a future situation which we cannot foresee in detail.

But it is possible to take political action mainly for the benefit of future generations, as exemplified by some large reforestation projects, and there are some problems in which the effect of today's action or inaction is fairly clearly predictable in spite of uncertainty of the details of the future international political situation. In these cases it is not right to excuse ourselves with the tenet "Sufficient unto the day is the evil thereof." So far as politically and economically possible, even if great initiative and public education may be involved, we should instead remember "A stitch in time saves nine."

Now that the atomic arms race is vigorously in progress, the problem of where it will end should be foremost among the world's interconnected worries. In the fairly optimistic view, it is a fairly long-range worry, insofar as an active temporizing diplomacy may be able to keep the tensions engendered by the growing stock within bounds for a decade or even more. But we cannot afford to let it go until then as completely unresolved as it is at present, without trying more vigorously than we have been to do something effective about it, for it may soon be too late.

As the possible solutions to the problem, the ways in which the atomic armament race might end without all-out atomic war, we may list: (1) total capitulation of one side to the point of view of the other without war; (2) a decisive world war with total abstention from the use of atomic weapons, following the very dissimilar poison gas precedent; (3) a war so soon as to catch one side atomically relatively unprepared and thus limit the destruction necessary by the other; (4) perpetual avoidance of war in spite of ever-growing potentialities of atomic destruction, perhaps aided by an unprecedented preponderance of continuously effective defensive weapons, an approach to infinity along a metastable path, or (5) international agreement on some sort of limitation of armaments including atomic armaments, and subsequent evolution of further arrangements to eliminate the possibility of war. Of these unlikely possibilities the last seems to us the least unlikely, and it is this solution that we wish to discuss.

What appears to be the more probable outcome of the situation, the widespread destruction of atomic war, we do not of course consider as a solution to the problem, although it might either end the atomic armament race for an indefinitely long period by destroying the necessary industrial capabilities and the culture for rebuilding them, or it might lead to atomic control by way of a world-wide dictatorship or other world government. This might spread from a sector of the world that had managed to remain neutral and intact, or it might rise from the ashes. Ultimately, there will be some sort of world-wide atomic (and other super-weapon) limitations or control, but it may come the hard way. Destruction of all life on earth would be the extreme hypothetical example, but short of that there are some other probable drastic modifications of the general evolutionary scheme with the introduction of this new instrument of destruction (and perhaps others) into the problem of survival. Adjustments are eventually to be expected tantamount to control over very long periods. But a triumph of human intellect in the next few years could avoid ruthless evolutionary upheavals by attaining within our present culture a rational super-atomic control.



DIFFICULTIES OF ATOMIC ARMAMENT CONTROL

The controlled limitation of atomic arms is a very difficult problem, so difficult that the frustrating events of the last five years have convinced most thinkers that it lies beyond the realm of present possibilities. Even if it is true that we cannot solve the problem at present, it may be that we can by our efforts at present and in the near future keep the problem from growing beyond the possibility of future solution. As has been pointed out,[1] one of the worst aspects of the long-range problem is the danger that stockpiles of atomic materials will grow so enormous that it will become impossible to provide, by arranged inspection of production facilities, even a remote idea of how much material has been produced. For then no conceivable atomic control plan can provide guarantees against the hiding of dangerously large secret stockpiles, large enough to be decisive in war if it should subsequently break out. If we get that far without halting the atomic armament race, a subsequent improvement in the climate of diplomacy will be of little avail. We shall have passed a "point of no return," and the race will almost inevitably go on to a disastrous doomsday.

So far, our country with the backing of the U.N. majority has made some enlightened and even generous proposals to try to bring about agreements to solve the problem, and our suggestions have most of the time been met with frustrating derision and with flimsy and incomplete counter-proposals, mostly of the historically unsuccessful "scrap-of-paper" variety. But we have not left every stone unturned. Having failed to solve the problem, we have as yet hardly approached the secondary task of trying to formulate an acceptable plan to halt the deterioration of the prospect of solution.

There has been some convergence of points of view in the U.N. negotiations seeking a solution, but a large gap remains. Both sides now agree to simultaneous discussion of conventional and atomic weapons and at least verbally to continuous inspection, although the meaning of the latter has not been clearly defined in the statement of the Soviet reservations. Our proposals in the Paris General Assembly meeting last autumn were more broadly exploratory than heretofore,

[1] D. R. Inglis and D. A. Flanders, "A Deal Before Midnight?" *Bulletin*, VII (October 1951), 305.

but they were not a complete plan. They were rather a demand for a complete arms census as a basis for negotiation aimed at cessation of production. If followed up with sincerity and flexibility in the present New York meetings of the U.N. Disarmament Commission, they could be the beginning of a plan to halt the deterioration of the prospect of eventual atomic control. It is fervently to be hoped that these sessions will enjoy an improved climate for constructive thought, unimpeded by propaganda efforts, in spite of the international tensions dividing the members, and that they will find some way to resolve the differences. Failing this, the preparation at a high national level of a complete atomic limitations scheme of nearly minimum requirements, and an attempt to convince the other side of the advantages, would seem to be called for as the next urgent step.

The discouraging experience of past negotiations is frequently generalized to the sweeping conclusion that the Soviet leaders will not agree to any inspection so that further consideration of atomic arms limitation agreements is futile. More accurately, and without any sweeping generalization, the type of incentive we have so far suggested has not led them to agree to significant inspection in connection with the general control plan. *We can't be sure that they will never agree to any and all significant inspection plans until we have presented all plans that could ameliorate the situation, and propounded them with emphasis on the incentives.*

MUTUAL INTEREST IN AVOIDING MUTUAL DESTRUCTION

Some of those who have seen the work of technical teams, sometimes including top scientists, dedicated to the solution of a difficult problem far beyond the possibility of solution by any one man, can't help believing that the group-effort technique should be applied also to the search for an acceptable solution to the international atomic control problem. The large scientific team that worked on the development of the atomic bomb, for example, tackled what was then a fantastic task (one which, it turned out later, was abandoned in Germany as impracticable). But they were encouraged by the fundamental fact that nuclear fission is produced by and in turn produces neutrons. After expending enormous patience and ingenuity on the concentration of fissionable atoms and on numerous other difficulties, this fundamental fact was successfully exploited.

If now a successor to the Acheson-Lilienthal committee should tackle the next phase of the atomic control problem, perhaps also an almost fantastic undertaking in the light of the frustration of Soviet tactics, this group should also be encouraged by the salient fact that it is fundamentally to the *mutual interest* of both sides of the conflict to avoid acting like the proverbial gingham dog and calico cat who ate each other up. Again it would require enormous patience and ingenuity to exploit the incentive provided by this fact in devising a limitation or control scheme which would be acceptable to both sides, in spite of the sacrifices (probably including a sacrifice of tactical atomic weapons) that would be necessary to provide adequate assurances of compliance. But the potential returns are so great that the group effort should surely be made, by the best brains available for the job. And it should probably be made "behind the scenes" where consecutive thought is possible on the long-range problem without concern for the effect of the effort itself on the short-range values of the propaganda war. It would appear that preliminary stages of some of the resulting negotiations might well take place behind the scenes, too, although the final stages will have to be open and will require public acceptance of the necessity of some short-term sacrifices for the sake of reducing the long-range danger. It may require bold political leadership to achieve broad public awareness of the problem without risking the short-term instability of panic. Surely the tendency of present publicity to deemphasize the danger and belittle the "frightened man" will not alone suffice, advisable though it may seem from the short-range point of view.

TACTICAL WEAPONS AND THE SIZE OF STOCKPILES

Production of concentrated fissionable materials in significant amounts is very difficult, so difficult that it is impossible for those of us who have been kept in the dark concerning the size of our nation's atomic stockpile to guess very well how large it is. Under these circumstances it has, until recently, been easy to be optimistic about the long-range problem and to hope that the atomic arms race is progressing rather slowly on both sides (with our own side ahead, of course!). In this spirit we might hope that the "point of no return" is a long way off, that solution of the short-range problems of world stability will bring us to a long period of waiting for a better international climate before trying to solve any long-range problems.

The recent public announcements concerning tactical atomic weapons no longer permit us any such optimistic leisure in considering the problem of eventual control. A very important implication of this announcement and the accompanying anonymous estimates of the size of our stockpile is that it is easier to make atomic explosives than we might have thought, that the "point of no return" is not so far away.

Until recently intelligent estimates of the stockpile might have ranged from fifty atomic bombs or less to a thousand or more. As a senator is reported to have complained[2] to one of the five commissioners of the AEC when trying to extract the size of the stockpile from behind the congressionally imposed veil of secrecy, "You have got two bombs or you have got one thousand or you have got six or seventeen, and we don't know what you have got." But in various remarks and quotations of "authoritative sources" accompanying the announcement of tactical atomic weapons we have heard mention of the numbers of atomic bombs available as "600" or "a thousand" or "soon to be expressible in four figures," with sufficient agreement as to order of magnitude as to give an awesome impression of the ease of making fissionable materials.

But quite apart from the probable reliability of these statements, the existence of tactical atomic weapons itself implies some such very large stockpile. For tactical atomic weapons are not peanuts. Even if very much weaker in explosive power than a 1945 atomic bomb, some rather general technical considerations suggest that they must use fissionable material in a quantity per weapon nearly enough as great as in such a bomb that they represent a great loss in total destructiveness available from the material. Unless these critical materials are available in quantity for many hundreds of bombs, it would seem folly for a military establishment to advise

[2] Senator McKellar to Commissioner Dean, *Bulletin*, VII (November 1951), 352.

diverting any large part for use in making less destruction than it might be capable of.

TACTICAL WEAPONS NOT SMALL AND ECONOMICAL

For the general impression that tactical atomic weapons range up from very small sizes almost comparable with conventional TNT bombs is very probably extremely misleading at least insofar as the consumption of nuclear explosive is concerned. Early in the atomic age it was publicly made clear that atomic explosions are possible only by use of a rather definite minimum amount of fissionable material known as a "critical mass," and that actual atomic bombs probably use not very much more than this minimum amount. An accurate estimate of the minimum amount that might be used in a tactical atomic weapon is not available, since no information has been released concerning the type of modification of the 1945 atomic bombs that is involved, although quite a lot has been divulged about the nature of the 1945 bombs themselves.

Those working on tactical weapons may not tell us how much uranium or plutonium they contain, but some of the known facts are suggestive. It is a matter of public knowledge that the two atomic bombs dropped in 1945 were of different types, one of which employed compression of the fissionable material by the pressure obtained from chemical high explosives in order to reduce the amount needed for a critical mass. It is also known that ordinary atomic piles have a different critical mass from bombs, partly because of the different neutron energy used, but that a pile out of control would make a very inefficient explosion. These facts suggest that there are tricks to the trade, and that allowance must be made for unexpected ones in making estimates. It is always hazardous to try to guess what discoveries may ultimately be possible, but a scientist acquainted with the fundamental principles of recent discoveries is in a better position to do so than is a technically uninitiated reporter. It is safe to assert that most scientists, being acquainted with the trends of nuclear masses and energies, would feel, on the basis of the unusual nature of the discovery of the nuclear chain reaction, that the fundamental principles involved in tactical atomic weapons must be the same as those of earlier atomic bombs, and that if there are special tricks they would probably not nearly reduce the order of magnitude of the fissionable material needed. Such consideration on the basis of unclassified information would lead also to the judgment that a bomb made with, let us say in hypothetical round numbers, one-tenth of the fissionable material of the original 1945 bomb, if this could be detonated at all, would not have one tenth of the explosive power, as the average thoughtful newspaper reader might expect, but much more nearly one one-hundredth or one one-thousandth of the power.

While it is in principle entirely possible to make an atomic bomb with only a very small fraction of the destructive power of a 1945 atomic bomb, this suggests that it is something like breaking a firecracker in the middle before igniting it to make it fizzle, that it is done not by greatly reducing the amount of fissionable material used, but by using it much less efficiently, the atomic "fuel" being only partly "burned."

A big bomb to do a small job may be wasteful. It is wasteful of fissionable material to the extent that a bomb a tenth or a hundredth as powerful made with, let us say, half the material could, with sufficiently accurate delivery, have done the job. Use of a big bomb to do a small job is immoral, and for this reason also politically unwise, at least to the extent that it destroys lives and property that need not have been destroyed to accomplish the military objective. Use of a small atomic bomb to do a small job is wasteful of fissionable material in the sense that, combined with a little more material, it would have been capable of doing a very much bigger job. If there is unsatisfied demand for the fissionable material to do the big jobs, or for the threat of doing them, then conventional explosives must be considered in competition with "small" atomic bombs for the "small" jobs. Here the cost of delivery comes into the balance, and the fact that this is measured in lives as well as material is, at least on our side of the struggle, probably considered a strong reason for diverting fissionable material to tactical weapons as soon as the demand for the threat of the big jobs begins to be nearly satisfied.

The power of the smallest practicable atomic bomb is thus not just a technical question but also one of economics. If there is plenty of fissionable material for all needs, relatively weak and wasteful bombs might reasonably be made. Technically there is no lower limit on the power, but only a "law of diminishing returns." We have, however, a good indication of about where the line has actually been drawn. Senator Brien McMahon, who has good reason to be informed on these matters, said in a recent interview with the *Bulletin*[3], "They may call them 'baby bombs' or 'tactical weapons,' but if it is an atomic explosion, its destructive power will be so great compared to any conventional kind of weapon as not to admit of a fair comparison." It is unfortunate that the journalists ever started using the misleading term "baby A-bomb," for we apparently have no such thing in prospect.

LATER THAN WE THOUGHT

All this adds up to the impression that it is later than we might have thought. The advent of tactical atomic weapons within the first decade of the atomic age indicates that the stockpile of strategic bombs can be built up far enough to approach the saturation point, at least on one side and so probably on both, in a matter not of a quarter or half a century, but in only a decade. Under these circumstances it is even more impressively true that there is no time to lose, if some rational way is to be found to avoid getting into a situation in which eventual disaster is practically inevitable.

NEWS OF TACTICAL ATOMIC WEAPONS—ESTIMATE OF DIFFICULTIES

The unique feature of atomic explosives, when one considers the problem of bringing them under some sort of control plan, is the compactness of the package in which enormous destructive power can be wrapped up, after a very intricate process of production. This makes it impracticable to find them by careful search once they have been produced, and ties the problem of weapon control closely to the process of materials manufacture and the

[3] *Bulletin*, VIII (January 1952), 10.

attendant industrial applications of atomic energy, as emphasized in the Acheson-Lilienthal report and the subsequent majority plan in the United Nations. This is the fundamental technical difficulty, which lies behind all the others, and it is changed not in general nature but only in certain details by the advent of tactical atomic weapons. Our uninformed estimate of the magnitude of the difficulty, as measured by the size of the stockpiles already manufactured and to be accounted for, is, however, greatly changed by the recent news.

There remain other serious deficiencies in our information that make it impossible to assess further details of the technical difficulties. If some high-level group undertook seriously to invent and evaluate all possible schemes for atomic control, it could presumably obtain better information on these questions and be influenced by it in the type of plans considered. One deficiency in our knowledge is the likelihood of attainment of a hydrogen bomb. If such a development were definitely anticipated, it might spell the end of any possibility of a control scheme, because of the greatly enhanced effectiveness of a hidden stockpile of fissionable material that might be made possible by the hydrogen technique, but even this should not be taken for granted without adequate study by a competent and informed group zealous to achieve control.

Another is the true relative advance of Soviet and Western developments. Widely-accepted rumor[4] accompanying the recent announcement of the possibility of tactical atomic weapons suggests that, whereas the United States stockpile is in the neighborhood of a thousand bombs, the Soviet Union has less than fifty. Press accounts attempting to give a factual basis for this disparate situation hinted that it was based on the opinion that uranium ore deposits available to the Soviets are limited to those known before the last war, since they are still working some depleted deposits. This appears to be just the usual sort of optimism that has on other occasions led us to underestimate the capabilities of our potential enemies. In a country whose geological exploration has been as primitive as Russia's, this basis for such a conclusion seems entirely inadequate. The longer time we have been at it would alone make our stockpile considerably larger than theirs, other things being assumed equal. Our much-emphasized industrial superiority may be more than compensated by the possibility that a much larger fraction of their more tightly controlled economy has been devoted to atomic weapons production.

But more important than present size of stockpiles may be the rate of production both of production facilities and especially of new ideas and techniques. If one attempts to assess impartially the probable Soviet advances in atomic techniques, on the basis of available information, which is almost none, he is faced with two opposing factors that must be adjudged. First, the fact that the Soviet effort was greatly aided by detailed knowledge of British-American techniques obtained through espionage, might have made it possible for them to have made a supply of almost replica bombs without having the sort of research organization that would make it possible to go on to new developments. Second, to the extent that they did develop a research organization, it did not have occasion to relax its efforts and disperse its personnel after achieving its first success, as was the case here. In this country the momentum of the original development was lost with dispersal of scientists to normal pursuits at the termination of the wartime incentive, but it does not seem likely that this was allowed in the Soviet Union, where there was no such change in incentive. Our recent attempt to regain much of the lost momentum, catalyzed by the announcement of the first Soviet bomb, may have failed to catch up.

Thus there is danger that the usual assumption of great superiority in this country may again be at fault in underestimating the capabilities of our competitor. Though disturbing in the short range, this affects one's judgment of the long-range problem mainly in connection with the types of incentive that might lead the Soviet Union to enter a control plan. It may not affect the "point of no return," which may be passed unilaterally.

RELIANCE ON TACTICAL ATOMIC WEAPONS—DIFFICULTY OF ATTAINING CONTROL

The advent of tactical atomic weapons apparently increases the political difficulties of attaining some sort of atomic control much more than it influences the technical difficulties. The detailed technical requirements of material accounting are, to be sure, extended by dispersal of the material through a wider variety of weapons and places, but as long as the main reliance in accounting is placed on inspection and analysis of production facilities, this is not a major change. The changes in potential international political attitudes toward atomic control when nations have come to rely on tactical atomic weapons for their ground defense may be enormous and decisive.

So long as atomic weapons were confined to their original strategic role, there was the hope that the two sides would each prefer not to start an atomic war and feel obliged to maintain force of conventional arms sufficient for its estimated needs. This seems indeed to have been the motivation of our current conventional armament program. With each side holding atomic armaments mainly for the threat of retaliation, but cognizant of the long-term instability of this threatening posture, it might seem politically impossible to convince each side to relinquish its stockpile under a system of adequate assurances of approximate compliance by the other.

The simplicity of this proposition arises from the neat separation of weapons into two compartments; atomic weapons for the obliteration of cities on the one hand; and conventional weapons for warfare between field units on the other. As soon as atomic weapons become mixed up with field warfare, such a neat separation of the categories no longer exists.

[4] Among the journalists speculating on these matters, the Alsops, for example, have mentioned a guess that the Soviet stockpile may grow from about fifty A-bombs in early 1952 to about two hundred and fifty in early 1955. As we go to press we note that this guess has been pushed up 50%. (Column in Chicago *Sun-Times* et al., Feb. 17, 1952).

Even in "small" wars of attrition, of which we now have examples in progress perhaps as part of a pattern, there will be strong temptation to use atomic weapons. This has been lately evident in political statements in this country. With tactical atomic weapons in use, small ones, larger ones, far from cities, nearer to cities, and with conventional bombing of facilities in cities being taken for granted, there will be no clear-cut dividing line. One result of tactical atomic weapons will be to make all-out atomic war seem more imminent, and the search for control schemes more urgent even from the fairly short-range point of view.

Senator McMahon has recently stressed[5] the economy that he anticipates will fairly soon be possible from the substitution of atomic firepower for massive armies in our regular military establishment. Once this substitution has been made, how additionally difficult it will become to convince a congressman, for example, to consider seriously ideas about atomic arms limitations! Before we get in that predicament, serious consideration should be given to the question whether we can afford to indulge in the short-term luxury of this relatively cheap temporary protection, rather than to continue with our main reliance in conventional defensive armaments, as long as there is a glimmer of hope that, with sufficient dedication to the task, atomic control may be achieved.

Our present program of conventional rearmament should be well along by 1954, and it is quite possible that tactical atomic weapons will not make a significant contribution so soon. In that case there may be a year or two, or perhaps more, at about that time, when we can "negotiate from strength" without reliance on atomic weapons, and thus be in a position to negotiate these weapons out of existence, or at least take significant steps in that direction. It will be a precious opportunity if it comes, and probably a last chance if the reports of tactical atomic weapons are well-founded. Thus, the rate of development of these weapons may become a measure of the number of minutes to midnight on the front cover. It behooves us to have our ideas on the advantages and costs and selling points of all possible control schemes well in hand before then.

[5] Atomic Weapons and Defense, *Bulletin*, VII (October 1951), 297.

ATOMIC CONTROLS IN DISARMAMENT PLANNING

DAVID F. CAVERS

Professor Cavers' interest in the problem of the international control of atomic energy is of long standing. Bulletin readers will remember his persuasive arguments for a moratorium on atomic power which he published in this journal in October 1947, and his "Interim Plan" which he described in the January 1950 issue. The present article recounts the developments in the recent U.N. meetings and explores the possibilities open to the newly formed Disarmament Commission, which merges the UNAEC and the Commission for Conventional Armaments. Mr. Cavers is associate dean and professor at the Law School of Harvard University.

SIX months ago who would have forecast that, thanks to American initiative, disarmament would hold the center of the stage through most of the General Assembly's session in Paris? The arms race was at full tilt. Both the U.N. Atomic Energy Commission and the U.N. Commission for Conventional Armaments were moribund. No break in the deadlock seemed imminent despite the occasional declarations of good intentions emanating from Washington and the world-wide communist propaganda centering on the Stockholm peace pledge.

The proposals put forward jointly by the United States, France, and Great Britain last November were met by the Soviet Union, first with derision, then with counter-proposals, and finally with concessions. These last probably were designed to recapture for the USSR the initiative it had lost, but conceivably they reflected a desire for genuine negotiation. The upshot of all this activity has, in any event, been the creation of the new twelve-nation U.N. Disarmament Commission, comprised of the Security Council members plus Canada, operating under a resolution substantially the same as that proposed by the three powers initially. The Commission has already been organized with Señor J. C. Muniz of Brazil as its chairman, and by the time this article appears may have received specific United States proposals for action.

However heartening the change may be to those who hope that some day the world will discard its dangerous burden of armaments, the current situation is a puzzling one. It seems clear, for reasons to be developed below, that the junction in a single commission of the functions of the U.N. Atomic Energy Commission and the U.N. Commission for Conventional Armaments has real promise for the international control of atomic energy. Yet, in sponsoring the new Commission, the United States failed to emphasize the significance of the change or to clarify the relation of general arms control to the control of atomic energy. On the contrary, its spokesmen, including both President Truman and Secretary Acheson, have reiterated fidelity to the U.N. atomic control plan "unless and until," as the Secretary put it, "a better and more effective plan" is developed.

This formula would have seemed more sweetly reasonable if it had not been repeated so often during the deadlock. In the context, a "more effective" plan would appear to call for more rigorous controls and so would be even less acceptable to Russia than the U.N.'s present plan. Hence, the statement has seemed equivalent to a declaration that we are standing pat.

In this connection it is also significant that the United States has made plain its continued adherence to the principle of international ownership and management of atomic facilities and stockpiles.[1] Since on no point was Russian opposition more intransigent, the fact that we did not choose the occasion of the merger of the two commissions to disembarrass ourselves of this principle is disappointing to those who hope for agreement. If the princi-

ple were important for national security or world peace, our own stubbornness would be understandable. However, as I shall try to make plain in this article, the principle is no longer important from the standpoint of security. Either we are saving the point as a "give away" in a later stage of negotiation, or we ourselves have failed to appreciate the changes which intervening events plus the merger of the two commissions have worked in the control problem.

THE NEW COMMISSION'S TASK

This article will examine the new situation which these changes have brought for the specific problems of atomic energy control, but first I shall outline the new U.N. plan. The Disarmament Commission's task is:

> to prepare proposals to be embodied in a treaty (or treaties) for the regulation, limitation, and balanced reduction of all armed forces and all armaments, for the elimination of all major weapons adaptable to mass destruction, and for effective international control of atomic energy to ensure the prohibition of atomic weapons and the use of atomic energy for peaceful purposes only.

In the principles which the resolution prescribes for the Commission's guidance, the "first and indispensable step" is a census—the "progressive disclosure and verification on a continuing basis of all armed forces and armaments including atomic." We have urged,[2] but the resolution does not require, that this census begin with the least vital and end with the most sensitive types of armaments, particularly atomic weapons. As in the case of the Baruch proposals in 1946, this resort to the "stages" device evoked Soviet objection. The Soviet Union approves the disclosure of existing armaments but would allow only one month for the entire process.

[1] In a press release on January 16, 1952, commenting on the Vishinsky concessions, Secretary Acheson said:

"It is perfectly clear that no system of inspection alone, be it periodic or continuous, can insure the effective prohibition of atomic weapons. . . . Under the U.N. plan the international control agency would own all the atomic materials and would own, operate, and manage all atomic facilities that make or use such materials in dangerous quantities. A system of control based upon these safeguards is the only one so far devised that can be both workable and effective. We are prepared to examine any other proposals that might be equally or more workable and effective."

[2] Secretary Acheson, Address before Political Commission, General Assembly, November 19, 1951.

In addition to the arms census, the directives call for plans for fixing "over-all limits and restrictions on all armed forces and all armaments." Though the resolution does not so specify, Secretary Acheson has suggested that the men in the armed forces of every country might be limited to a prescribed percentage of its population, subject perhaps to an overriding absolute maximum. Similarly, the proportion of each country's national production devoted to military uses might also be subject to a ceiling.

The actual treaties embodying the over-all limits and restrictions are to be left to negotiation by the states among themselves, under Commission auspices. Within such ceilings, the resolution contemplates that the nations would also negotiate the allocation of the manpower and expenditures to the various types of armaments so as to prevent the concentration of resources in ways calculated to increase military potential.

Secretary Acheson indicated that he would prefer to see the new Commission develop and carry out plans for the arms census first, but he is quite willing to have it develop the entire scheme of control, including the census, to be embodied in a series of treaties to go into effect at one time. Although obviously it would be easier to work out a satisfactory arms control plan if the planners knew exactly what armaments the parties to it possessed, nevertheless, the Soviet Union's stress on military secrecy makes it seem almost certain that the latter course, if any, will be followed.

Though the proposed treaties would look to the elimination of weapons of mass destruction and the prohibition of atomic weapons, I find in the pertinent language of the resolution (which is quoted above) no clear indication whether that prohibition represents an ultimate goal to be achieved after an extended period of balanced reductions or whether it is expected to go into effect at the start or at some intermediate stage of the control plan's operation.[3]

This may prove the most difficult of the series of specific problems of atomic energy control which confronts the new Commission. A convenient way to analyze them is to examine the impact of the new situation on the three chief dangers which an atomic control plan must be designed to safeguard. These are: (1) the danger of illegal diversion of fissionable materials from atomic facilities or stockpiles; (2) the danger of secret production of fissionable materials; and (3) the danger of illegal seizure of atomic facilities and stockpiles for military use.

THE DANGER OF DIVERSION

In view of our emphasis on the principle of international ownership, it is noteworthy that the danger of diversion is the only one of the three which that principle is designed to diminish. Since it would place all facilities in the hands of the international staff, there would be no need to rely on accounting and inspection beyond the staff's own internal security measures. The Soviet Union has insisted, vehemently if not persuasively, that, in addition to violating national sovereignty, the principle of international ownership is a scheme to permit the power-rich United States to monopolize the development of atomic energy and thus to impede the Soviet's economic growth. She has therefore insisted on the national ownership of atomic facilities and stockpiles, conceding to the control organ only the powers of requiring accountings and making periodic inspections of the declared atomic facilities and stockpiles. We, in turn, have objected to periodic as contrasted to continuing inspection, but the problem was never examined in sufficiently specific terms to enable the significance of the differences for security to be gauged. In any event, Vishinsky's concession has eliminated periodicity of inspection as a condition to Russian agreement.

Because it never had to face the problem, the old U.N. Atomic Energy Commission did not develop accounting and inspection procedures to prevent any substantial risk of diversions of fissionable materials. If we now are

[3] In President Truman's radio address, November 7, 1951, he says that atomic weapons "would *ultimately* be prohibited" under the U.N. plan. (Italics added.)

to insist that such controls cannot work, our position demonstrates the impossibility of establishing any "foolproof" control plan at this time. We are no longer back in 1946, when the American stockpile was tiny and the Russian non-existent. Both nations have been engaged in turning out fissionables at breakneck pace for a number of years. During this time, of course, they have been subject to no inspection whatever. Unless, by accounting and back-checking, we can get some fairly accurate idea of how much Russia has produced, how can we or the control body know that the stockpile declared by the Russians even approximates their total holdings? If, on the other hand, a fairly close check can still be made, then certainly a system that reinforces accounting with continuing inspection (aided perhaps by protective specifications for reactor design) should give assurance that no large supply of fissionables was being stored for a future war.

In view of the lateness of any control plan we may adopt, we must resign ourselves to the fact that it cannot be airtight, that, at most, it can only assure the inability of either side to launch and sustain a devastating atomic war. But we should remember that the old U.N. Commission's efforts, understandably enough, were aimed at developing an airtight plan. This was a major reason for relying on international ownership and management. With that goal abandoned, the means to its attainment become dispensable.

Moreover, any precaution against the danger of diversion assumes the continuance of operations from which diversion might take place. If an overall arms control plan is adopted, however, this assumption becomes very doubtful. For an indefinite number of years, neither nation will have peaceful uses for more than a tiny fraction of its existing atomic piles. Moreover, to convert U-238 into U-235 or plutonium for peaceful purposes while there remains a chance of developing an effective breeding process, means the irretrievable waste of large quantities of a precious natural resource. Any sensible control plan would therefore call a halt to all but the small-scale operations required for the production of isotopes and for other research and development activities.[4]

Certainly international ownership and management is not necessary for these purposes; indeed, it might prove an impediment to progress. I wonder, finally, whether the United States people or the United States Senate would really prefer an international agency to take over the ownership and operation of our atomic facilities. Whatever their views in '46, I believe today they would be more likely to share the Soviet preference for national ownership.

THE DANGER OF SECRET ATOMIC PRODUCTION

The danger of secret operations is substantial. In seeking to meet it, the draftsmen of the U.N. majority plan were faced by the difficulty that an inspection plan which would check the secret production of atomic weapons would also compel the disclosure of military installations and dispositions. Though the U.N. draftsmen labored valiantly, the compromise they produced afforded doubtfully adequate protection while impairing Russia's reliance on military secrecy. Russia agreed to inspection of declared facilities only, except upon suspicion of violation—a qualification which is meaningless for a country where freedom of movement does not exist.

Fortunately, this inspection problem has disintegrated under the impact of the new proposals. If a plan of general arms control is ever put into force, a basic element must, of course, be a continuing program of inspection. There can remain no substantial military secrets to conceal. The same inspection operations which will give assurance that there is no secret build-up of conventional armaments can be adapted to give like assurance against the build-up of secret atomic stockpiles.

The question naturally arises whether Russia will allow the Iron Curtain to be penetrated by inspectors charged with checking conventional armaments. As to this, the evidence is not entirely clear, but there are grounds for encouragement. In offering its counter-proposal to the three-power resolution, the USSR stipulated that a function of the international control organ would be the "checking of information presented by the states about the status of their armaments and armed forces."[5] This is vague, and it may be that the USSR contemplates only a single check, and then only of declared installations and dispositions. However, in the report of the subcommittee of the four major powers, which was created in Paris at the insistence of the smaller countries, there appears some additional and more encouraging language, reading as follows:

Safeguards.—All four Powers are in agreement with the necessity for safeguards to ensure observance of the programme. The representative of the USSR stated that he had no objection in that respect, since the international control organ would have the right to carry out special investigations when suspicions of a breach of the convention on the prohibition of atomic weapons arose. The Three Powers pointed out that the safeguards which they have in mind are more extensive in nature than special investigations alone, and furthermore that these safeguards apply to conventional armaments as well as to atomic energy.

The USSR representative stated that that formula would involve inspection on a permanent basis, and that the USSR delegation objected to such a measure. *The USSR delegation did not, however, object to the application of such safeguards to the reduction of conventional armaments.* [Italics added.]

Although the report itself was prepared by the subcommittee's chairman, Dr. Padilla Nervo of Mexico, president of the Assembly, nonetheless, its language was approved by the representatives of the four powers. Furthermore, the significance of Russia's reservation on the score of atomic inspection has been sharply reduced by Vishinsky's subsequent concession (January 13, 1952), on the score of periodic inspection. His vague qualification that the control organ "shall not be entitled to interfere in the domestic affairs" of the inspected state suggests that he may have realized that atomic inspection would range farther than the atomic facilities themselves.

The ingredients for a deadlock remain in the question whether the initial inspection should be carried out in stages, as we have proposed. Now that Russia has the "secret" of the bomb, we do not have the same interest in postponing disclosure of our atomic facilities and stockpiles as we once had—or thought we had. Moreover, we stand to learn more ourselves from the inspection process than was

[4] This is a point which I have previously advanced. See Cavers, "Atomic Power versus World Security," *Bulletin*, III (October 1947), 283; "New Life for the UNAEC," *ibid.*, IV (December 1948), 335; "An Interim Plan for International Control of Atomic Energy," *ibid.*, VI (January 1950), 13. Certainly the subsequent piling up of stockpiles should have clinched the point, even for the Soviet Union.

[5] USSR plan submitted to General Assembly, November 16, 1951.

once the case. Compromise seems possible here.

THE DANGER OF ILLEGAL SEIZURE

In my opinion this danger has always been and remains the most difficult to control. The principle of international ownership and management contributes nothing on this score. The fact that the legal title to an atomic stockpile east of the Urals or in Fort Knox, Kentucky, was vested in a U.N. control agency would give only the illusion of protection against seizure if either the USSR or the U.S. were seizure-minded. Moreover, since concealment or undetected fabrication of bomb mechanisms is a possibility which no control plan can prevent, stockpiles of fissionable materials represent potential weapons. Indeed, in the circumstances, it is hard to imagine disarmament as being complete as long as they remain in existence.

For the draftsmen of the U.N. plan this was only a future hazard, given the smallness of the stockpiles then existing. To meet it, they adopted the principle of "strategic balance," by which each side was to have approximately the same facilities and stockpiles so that, if one side were to seize illegally, the other could retaliate effectively. Today it is very difficult to see how the principle of "strategic balance" could be employed.

Let us assume that we have a stockpile of one thousand bombs and the USSR, a stockpile of one hundred. Assume that the bomb mechanisms are to be destroyed but that the atomic fuel is to be preserved. How then do we achieve strategic balance? Certainly we are not going to give the USSR the makings of four hundred bombs so that we may have balanced stockpiles. It is almost equally inconceivable that we should freeze our stockpile at a thousand and allow the USSR to add the makings of nine hundred to its own.

A possible alternative is for us to preserve our advantage in fissionables but to use it to counterbalance the USSR's superiority in certain types of conventional weapons. Each side would then reduce progressively its arsenal, but how the fissionables would be disposed of has not been made clear.[6] In any event, this plan would require the continued tolerance of the A-bomb as a weapon which, though understandable in view of its increasing tactical potentialities, is hard to square with the language of prohibition in the U.N. resolution. Moreover, the plan is a far cry from the U.N. majority plan to which we have reiterated our adherence. Certainly international ownership and management is inconsistent with it.

The seizure danger presents a paradox. Where one power has vastly greater stockpiles and facilities than its rival, naturally one would suppose that the latter would be the power which would press for sharp reductions in stockpiles and strict curbs on production. Yet we find the United States arguing the need for controls in addition to inspection while Russia seems oblivious to the seizure danger. Each power seems the advocate of what is in the national interest of the other—a fantastic situation that I suspect is due, not to machiavellian tactics, but to lag. Neither side has yet revised its political position to reflect the mushrooming of the American atomic establishment.

Perhaps this very fact will work for agreement, since change of position in the direction of agreement can also be change in the direction of national interests. However, the problem is obviously an unsolved one. Possibly its resolution will lie in developing effective controls over the means of bomb delivery and over war potential generally. For nations otherwise disarmed, even enough atomic explosives to produce reciprocal cataclysms might not afford the temptations to war that arrays of regiments and fleets of warships traditionally have produced.

THE NEED FOR A FRESH LOOK

A treaty for the reduction of armaments is peculiarly difficult to negotiate at a time when international tensions are high. Every concession appears to be yielding an advantage to the enemy in the war that may be just around the corner. The problem has been accentuated by the development of atomic and other weapons, the full military potentiality of which has not been determined in experience. In these circumstances, rather than strive vainly for arms reduction or limitation formulas, I believe we would do well to negotiate a stand-still agreement, backed by adequate inspection. In 1953 neither side will have the preponderance of offensive power to overwhelm the other. The halting of the arms race then should itself sharply reduce the existing tensions. Perhaps the negotiation of positive measures for reduction might then become feasible, even though many political issues remained unresolved.

Disarmament negotiations have a bright side. When a political settlement is negotiated, each side is obliged to give up interests which it wishes to maintain, and, to make the process more painful, the interests yielded must usually be surrendered to the other side. In contrast, the reduction of armaments relieves the participants of a burden that is rapidly growing intolerable to both. Moreover, concessions by one side do not represent acquisitions by the other. They may, to be sure, affect the balance of security, and this must be guarded against, but, once reduction has been pushed to the point where aggression is militarily impracticable without a protracted preliminary build-up, this hazard shrinks in importance.

The popular response that greeted the reopening of disarmament negotiations in Paris last fall is indicative of the tremendous support that can be mustered for a genuine program. However, the subject is so vital that the individual negotiators are constantly on politically dangerous ground. This makes clarification of the present situation all the more important.

The dangers I see in our reiterated declarations of adherence to the old U.N. atomic control plan are twofold. Inside this country, they will lead many people to look upon future departures from its obsolete provisions as the work of hoodwinked idealists or disloyal appeasers, rather than to recognize them as steps taken in the national interest and essential to agreement. Outside this country, the weakness of the case for international ownership and management will grow increasingly clear. If we persist in clinging to this feature of the old plan, nations on our own as well as on the other side of the Iron Curtain will come to suspect the genuineness of our desire for arms control.

The handling of this situation calls for resourcefulness and freedom from preconceptions. For the past four years, no new ideas for atomic controls have come from American official sources. However, now that the State Department has engineered a major change in the U.N. machinery for disarmament planning, perhaps it will soon take a fresh look at the greatly altered atomic control problem.

[6] I have suggested the creation of an international depository for national stockpiles, to be situated at a place bilaterally vulnerable to attack, storage to be under conditions rendering seizure a practical impossibility. Cavers, "An Interim Plan for International Control of Atomic Energy," *Bulletin*, VI (January 1950), 13. Certainly other ways of attaining the same ends can be devised.

DOMESTIC CONTROL OF ATOMIC ENERGY

PART III

ROBERT A. DAHL and RALPH S. BROWN, Jr.

With this installment, the Bulletin brings to a close the condensation of the Social Science Research Council's pamphlet bearing the same title as this series of articles. The first two installments appeared in the January and February 1952 issues. The original pamphlet appeared over a year ago, and this condensation represents less than one-third of the original contents. Preparation of the condensation was undertaken by the authors of the pamphlet, Mr. Robert Dahl of Yale University, and Mr. Ralph Brown of the Yale Law School.

PRIVATE ENTERPRISE: THE CONTRACTOR SYSTEM

More than 90 per cent of the Commission's expenditures go to contractors. They prepare the materials for its plants; run the tremendous installations producing fissionable materials; govern the towns near these installations; carry on the research on which future developments—peaceful or military— will be based The bomb itself, one gathers, is fabricated by contractors. The Commission, of course, supervises and controls all these activities.

This section surveys the questions whether contracting, as it is practiced, is an effective means of administering a public responsibility; and whether it is an adequate response to the statement of policy in the Act [Sec 1(a)] that "the development and utilization of atomic energy shall . . . be directed toward . . . [among other goals] strengthening free competition in private enterprise."

GOALS OF CONTRACTOR OPERATIONS

The Commission's combination of delegation to delegation to contractors with decentralization of administration is intended to promote a number of goals;

1. Efficient operation. Contractors are expected to show better results in costs, speed, quality, and inventiveness than could be shown under direct Commission operation.

2. Efficient administrative performance by the Commission. Delegation of operations and decentralization of control over operations leave the commissioners, their chief aides, and their assistants, relatively free for staff functions—planning, appraising, coordinating—without harassing concern with day-to-day operations

3. Dispersed and limited government power, achieved by pushing important functions out of government altogether, though of course the AEC is responsible for results.

4. Dispersed and competitive private economic power. This goal is illustrated by Section 7 of the Act, relating to the Commission's licensing of non-military uses of atomic energy:

"Where activities under any license might serve to maintain or to foster the growth of monopoly, restraint of trade, unlawful competition, or other trade position inimical to the entry of new, freely competitive enterprises in the field, the Commission is authorized and directed to refuse to issue such license or to establish such conditions to prevent these results as the Commission, in consultation with the Attorney, may determine."

MINOR CONFLICTS WITH GOALS

1. *Effects of cost-plus contracting.* If the efficiency of a contractor is assumed to exceed that of direct government operation, it is usually also assumed that most of this advantage stems from the profit motive. What happens to this superiority when the job is cost-plus, as many AEC projects are? Reasons for the adoption of such a disfavored policy include: the need for secrecy, which inhibits wide distribution of specifications; the absence of specifications on novel undertakings; the immeasurable hazards involved in handling fissionable materials (contamination, explosion).

One task calling for research is to bring to bear on AEC policy the experience of other government agencies, and to draw from AEC practice whatever inferences can be made about the consequences of employing contractors when their expenditures are fully reimbursable. What leads AEC to believe, under such circumstances, that the contractor performs economically?

2. *Effects of avoiding conditions generally applicable to direct government work.* One man's red tape may be another man's public policy. Government employees are subject to certain disabilities, privileges, and uniform conditions of employment. Contractors' employees have been given a degree of governmental protection of their wages and hours in the Walsh-Healey Act and related statutes. Does Congress, in the mass of legislation affecting either government or contractors' employees, indicate what it wants the scope of either category of legislation to be? If it does, what of the extensive delegation practiced by the AEC?

3. *Effect of possible duplication of functions.* Does a large contractor (and the AEC deals chiefly with large contractors) operate at a level of complexity requiring research, auditing, security, personnel, and other staffs of the same sort required by the AEC to guide and appraise contractors' performance? Some insight into these problems might be a useful by-product of a major study of the concentration issue.

The advantages of working through contractors depend on their identity, on the number of contractors, and on the types of contracts. The editors of *Fortune*, in a useful article on the contract relationship, give a neat equation:

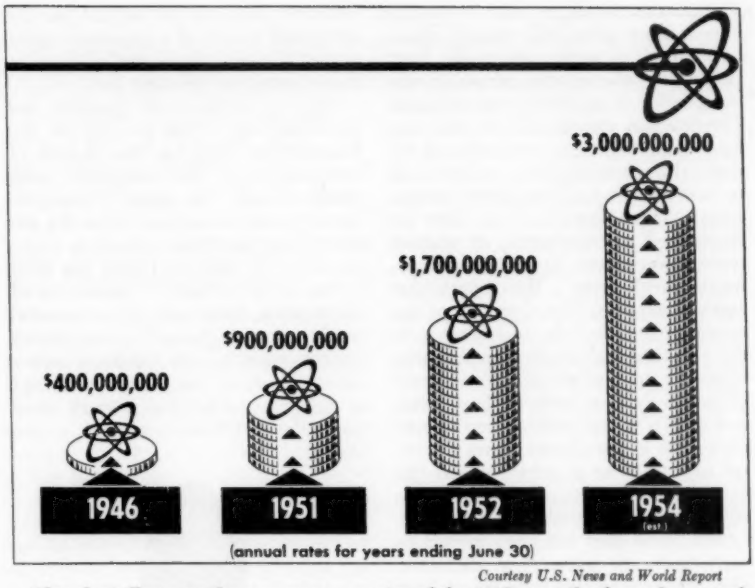
Dealing with big business = Small AEC
Dealing with smaller business = Huge AEC[1]

But the reliability of the formula and its implications need further examination. In the first place, are we sure that the only way to have a small AEC is through dealing chiefly with big business? Is the converse second equation necessarily true? For example, were no means of dealing efficiently with small suppliers developed during World War II, that are capable of development and extension? Suppose it does turn out that the only way to have a small AEC is through delegation of most of its functions to big business. Is that a good bargain for the American people?

A rough checklist can be made of the degree of concentration in atomic enterprise. Most ore comes from foreign sources, principally the Belgian Congo and Canada; little information is available about the producers.

"Mining, milling and processing the uranium ores into high-grade concentrates, within this country" is described by Lilienthal as one of "at least three areas in this undertaking where private business can operate in substantially the usual manner." Our impression, however, is that milling and processing, like mining, are in fact in a very few hands. The conversion of finished uranium feed-materials into fissionables is carried on at present by two companies—the Carbide and Carbon Chemicals Corporation at Oak Ridge and the General Electric Company at Hanford. Du Pont will re-enter the production program as operator of the new plants, in South Carolina, while the operator at Oak Ridge will also run the projected new gaseous diffusion plant at Paducah, Kentucky. Meanwhile, the General Electric Company and the Carbide and Carbon Chemicals Corporation are by far the largest contractors

Construction of AEC facilities is relatively widely shared. The major contracts are identified, although of course their details are not often revealed. The same is true of equipment supply. A tabulation of known contractors and subcontractors in supply and construction would probably make an impressively long list, but it would also be a blue-ribbon list of large companies.



Courtesy U.S. News and World Report

This chart illustrates the enormous expansion of the AEC since the days when it took over from the Manhattan Engineer District in 1946. It will be observed that the projected annual budget for 1954, if Congress accedes to the requested appropriations, will be greater than the entire cost of the whole atomic project during the war—$2 billion.

A sketch of concentration in research among universities would show Chicago and California at the top. General Electric and Carbide and Carbon again are the largest industrial research contractors, the former as operator of the Knolls Atomic Power Laboratory and the latter as principal contractor at Oak Ridge National Laboratory, with which a group of southern universities is also connected.

The latter corporation also dominates radioisotope production. The industrial preparation and use of radioactive tracer compounds is the second field described by Lilienthal as offering opportunities for private enterprise; but at present it is a minuscule operation beside the production of weapon material. The third field where normal competition may be appearing is the manufacture of radiation detection instruments, but like the production of isotopes this is negligible in size.

One might usefully examine the argument that the scale of production requires the AEC to rely on industrial giants. Conceding that each wartime plant is an indivisible unit, what about the large additions to Oak Ridge and Hanford since the war? Do they require coordinated management? Or are they separate units which could be turned over to new contractors? If the answers to these questions preclude division of operation, were there practicable alternatives that could have resulted in separate units?

Somewhat similar questions may be asked about the distribution of construction contracts as related to the size and number of projects. To what extent and for what reasons were they awarded to the present contractors? What degree of subcontracting followed? Have a few contractors obtained a high proportion of all jobs?

Even if Hanford is indivisible, is it essential that the General Electric Company operate the town of Richland, and, across the continent, Knolls Atomic Power Laboratory? Similarly, even if the gaseous diffusion plant is indivisible, is it essential that the Carbide and Carbon Chemicals Corporation run nearly everything at Oak Ridge: the laboratories and Y-12, the electro-magnetic plant for separating uranium 235, now used only for producing isotopes?

There are other reasons than scale of operation for the dominance of the few primary contractors who receive more than half of the Commission's annual expenditures. One is that secrecy requirements often make it impossible to advertise for bids or to publish descriptions of what the Commission wants done. Consequently the

[1] "The Atom and the Businessman," January, 1949.

Commission tends to turn to experienced firms with full security clearance. Another reason given—the most perplexing one—is the supposed unavailability of additional participants. Construction clearly can be and has been undertaken by a number of industrial engineering firms accustomed to heavy plant and equipment assignments. These firms in turn draw on specialized manufacturers of various types of equipment—ventilators, pumps, magnets—whatever the particular method requires. The operation of the existing plants has obviously drawn on the chemical and electrical equipment industries, both of which are composed of relatively few units of large size. But even if we take the degree of concentration in the chemical and electrical industries as a datum which the Commission has to accept, there are still a surprising number of nonparticipants. Have they not been invited to participate, or have they declined? Also, there are related industries whose technologies seem to the layman not unrelated to atomic energy operations. The Standard Oil Development Company has played some part in engineering research work, but it does not appear that the large oil companies have been much involved with the Commission.

Assuming that the AEC does delegate extensively to a few contractors, what problems arise? Do AEC contracting policies tend to increase the existing degree of concentration in the industries involved? No effect on plant and equipment holdings is immediately perceptible, because the AEC retains title to all physical facilities; there is not even the prospect, latent in World War II expansion of plant by the government, of a sacrifice sale to the entrenched operator.

The opportunity for increased profits is variable. At one extreme the contractor by a negotiated contract may fence off a field where he earns monopoly profits. At the other extreme the contractor may actually weaken himself by doing Commission work on a nonprofit basis. The du Pont Company has insisted on such arrangements, and the General Electric Company asserts that its Hanford contract is profitless in fact. Even where there is a conventional management fee above the fully reimbursable costs of most negotiated contracts, it is hard to say whether the arrangement is "profitable" in the sense that the contractor could not earn more through other uses of the resources he devotes to the AEC. In this connection, note that the resources used are not capital but the combined talents of a group of corporate employees who do not themselves share in the management fee.

We may rephrase the question, and ask what effect the policies of the Commission have on the degree of competition in the industries with which it deals. The extent of competition is harder to measure than the degree of concentration. In markets dominated by the AEC as buyer, the most it can do is to foster a semblance of competition, since one of the essential conditions of a classically competitive market—many buyers and many sellers—is absent. However, a careful attempt to create competitive stimuli may make the semblance as good as the reality.

In any case, the nonprofit management contract has, in the opinion of some critics, nothing to recommend it to a society accustomed to thinking in terms of profit and loss. Commission representatives freely admit their preference for a more "normal" relationship. The insistence of the du Pont Company, for example, on full costs plus $1 may stem from special characteristics of that Company—its reluctance to expand further in the face of antitrust threats, or its experiences during the 1930's. In some cases the motive may be a patriotic gesture, and in others an eye to future advantage through the accumulation of "know-how" in a promising field. In any event the awkward mixture of profit, patriotism, and technological advantage that characterizes the big contracts seems to suit them only to leaders in industry.

The effect of concentration in contracting on the future position of contractors in the atomic energy field is the final large problem that arises from such concentration.

Current uncertainties about costs do not mean that nuclear energy has no peaceful future. The "dual purpose" reactors proposed by President Thomas of the Monsanto Chemical Company may bring commercial applications to early reality. Even if Commissioner Pike is justified in cautiously warning that "we may never get the cost down to where the present cost of power is,"[2] the depletion and increasing recovery costs of present fuel sources make the prospects of atomic power significant.

Two preliminary assumptions that seem plausible, although they need investigating, lead us quickly to a prediction concerning the probable effect of present contract practice on future control of the atomic energy field. The first is that to a singular degree mastery of atomic technology is acquired through actual experiment and operation in the field. The second is that if some firms have a five- or ten-year start in acquiring "know-how," there is little likelihood that latecomers will be able to challenge the pioneers in private markets. Both assumptions are impressionistic.

Our prediction is a simple deduction from the foregoing premises: To the extent that participation in the atomic energy program is now concentrated among a relatively few big contractors, future concentration of control of the atomic energy industry in the same interests is highly probable.

Besides critical examination of this prediction, attention may be directed to some problems that emerge from it. If it is correct or likely to be correct, why are many industrialists apathetic toward participation in atomic energy programs? The Commission's Industrial Advisory Group, in its report of December 15, 1948, has replied that, "Today no one can say whether the prospects of profits or other incentives exist, because under present conditions the great majority in industry know little or nothing about the subject." We gather that the Commission's recurring problem is to find firms to undertake projects, rather than to choose among worthy applicants.

What can the Commission do about business apathy, if it exists? Can the AEC broaden its contract base? Is it true that there are not enough qualified firms? If there is a shortage of qualified primary contractors, what explicit policies have been or can be adopted to expand subcontracting? In the construction business it is not uncommon for firms to form temporary partnerships for large projects either informally or through the creation of a jointly controlled subsidiary; AEC work has been done in this way. Is there anything promising in this approach? Could six medium-sized electrical equipment companies pool their resources to build and operate a reac-

[2] *Washington Post*, May 5, 1950.

tor? What would be the attitude of the Anti-trust Division toward such an arrangement?

Suppose that the Commission embarked on a bold program to prevent future technical advantages from accruing to present contractors, and that it devised means effective for this purpose. Then, when the field of atomic energy was opened to private claims, no one would have an advantage. Even so, a final dilemma emerges. If the incentives of qualified contractors are as feeble as some accounts suggest, and if those incentives, according to the Industrial Advisory Group, include the hope of "getting an early start in an important new field," what happens if that particular incentive is withdrawn? Here is a delicate problem in the psychology of innovation and enterprise.

The whole area of implications of the AEC's contract system, mostly economic but partly legal and partly sociological, seems to merit investigation. To many questions raised we can see no clear way of obtaining answers. To others, particularly to questions of business fact about contracts and contractors, security considerations are less forbidding than one might think.

It may well be that closer acquaintance with the details of contract administration may lead to inferences and conclusions that tend in a quite different direction from the hypotheses here suggested. For example, Richard Tybout, who is preparing a doctoral dissertation in this field at the University of Michigan, writes that: "Skilled management and technical teams, particularly the latter, have tended to remain with their jobs upon a change in operating contractors at Oak Ridge and Hanford." His discovery of the immobility of management personnel may lead to conclusions that quite discredit our notion that the accumulation of "know-how" is one key to the motivation of big contractors.[3]

[3] Research in this area with regard to commercial uses of atomic energy includes *Economic Aspects of Atomic Power, An Exploratory Study*, 1950, Sam H. Schurr and Jacob Marschak. Another study that will touch upon some of the same questions is being carried out under the direction of Walter Isard of Harvard. A doctoral dissertation by Robert L. Allen, also under Isard's direction, will attempt to examine some of the implications of power costs for the pattern of industrial location.

Richard Tybout's dissertation, mentioned above, studies the present system of producing fissionables and should deal with many of the questions raised here. James Newman has a forthcoming paper on the same subject. [See *Yale Law Journal*, 60:1263, 1298 (Dec. 1951)].

SOME PROBLEMS OF GENERAL THEORETICAL SIGNIFICANCE

It is our impression that study of atomic energy operations will be most fruitful for those who are interested in combining empirical and speculative work. A rephrasing in broad terms of some questions already discussed may suggest the kind of research which might be useful:

1. Although there is some concern and a considerable amount of undisciplined speculation on *the effects of secrecy on the democratic process*, no careful analysis has come to our attention.

2. What do the atomic energy operations suggest as to the need, prospects, techniques, and problems of *economic planning*?

3. In this connection, a careful study of the applicability of the *AEC-contractor relationship* on a wider scale might be useful. Does it suggest a new "middle way" technique for utilization elsewhere?

4. What can be learned about *business incentives* from a study of the program?

5. What can we learn about the *role of leaders in the making of decisions* in American democracy?

6. The atomic energy operations are perhaps a perfect laboratory for studying the problems involved in the *relationship between laymen and experts in a complex situation*.

7. Closely related is the question of the relationship between government and natural science research.

Study of the AEC may cast some light on these seven topics of contemporary importance. Conversely, study of these topics in other contexts may be revealing and helpful with respect to the AEC. The scholar may object that while any citizen can advocate legislative policy, judgments and recommendations cannot yet be made on any scientific basis. But at least a beginning toward policy judgments and recommendations can be made. Bold challenges like Lilienthal's, whatever their ultimate merits, invite a detailed re-examination of the McMahon Act. Such an inquiry, drawing on several disciplines, could hardly fail to produce something of value to the Commission and to Congress.

Consider the range of possibilities that might be proposed if a major revision were embarked upon:

1. On grounds of military necessity it might be decided to concentrate exclusively on weapons production.

2. As part of a universal disarmament program the production of fissionable materials might be discontinued (except for experiment), on the grounds that significant peaceful applications are remote and any production is too easily diverted to bombs.

3. The present program might be continued with major emphasis on weapons and minor emphasis on development of reactors under government control.

4. The present program might be revised without necessarily changing its objectives. Changes in organization and control could take several important new directions:

(a) Toward total government control and operation.

(b) Toward more direct government research and operation and more independence in private research and operations—the aim being crudely to achieve some sort of "yardstick" comparisons.

(c) Toward altering the present contract system to give priority to the creation of a quasi-competitive system.

(d) Toward reliance on private enterprise to develop industrial uses of atomic energy. Two proposals of importance have been made. Lilienthal made a general plea in his *Collier's* articles in 1950. The second current proposal is the Thomas plan for joint production of electrical energy and plutonium.

We cannot begin to consider here the possible social consequences of any of these choices. Some implications have been indicated at certain points in this report; others will occur to the reader. This much is clear: the release of atomic energy is the first significant technological innovation in man's history that *could* be introduced with a degree of social intelligence, foresight, and planning. The somber international scene and the attendant oppressive requirements of security by concealment hinder the free play of inquiry; but there is still enough information to warrant study, thought, and planning for domestic control of atomic energy.

THE FUTURE OF OAK RIDGE AND RICHLAND

The Recommendations of the Scurry Panel on AEC Community Operations

Summarized by W. FRANK McELDOWNEY

The problems involved in introducing private ownership and self-government in the communities now owned and operated by the Atomic Energy Commission have been studied by several groups of experts. My Lyman Moore submitted a series of recommendations in 1948, which he summarized in his article for the Bulletin *in January 1951. A study of the feasibility of incorporating Richland as a town and disposing of government property there was made by the Public Administration Service in April 1950, and a similar study of Oak Ridge was made by J. L. Jacobs and Co., of Chicago. The most recent report of this kind, "The Scurry Panel Report," appeared in August 1951 and is summarized here. The special panel included Richardson G. Scurry, chairman, Frderick M. Babcock, George E. Bean, and George Gove. These recommendations are currently under consideration by the AEC and citizens groups at the communities. Mr. McEldowney is an expert in real-estate transactions in the Chicago area.*

THE Panel selected by the U.S. Atomic Energy Commission in the summer of 1950 to report on Community Operations in the communities of Oak Ridge and Richland has submited its findings. The members were asked to express opinions and offer recommendations relative to charging these communities with greater responsibility for the various community services now managed by the AEC. The primary consideration was the success and security of the Commission's program, and managing the change-over so as to increase local autonomy for the residents and effect economy for the federal government.

The advantage to be derived from relieving AEC from real estate and municipal operations is obvious. The report favors incorporation of the communities and disposal of residential and commercial properties that are now owned by the federal government and managed by the AEC. The present "company-town" situation ought to be corrected, says the report, because it would redound to the benefit of the government in better worker-staff relationship. Although economy to the federal government is a hope, the Panel does not represent it as likely in the near future. Perhaps the savings already effected (reported by Mr. Lyman S. Moore in the *Bulletin* for January, 1951) should be recalled.

The cost of municipal operations in the two towns of Oak Ridge and Richland in the fiscal year 1948 was $21 million. The reform of the accounting system inaugurated the next year seems to have been a success, for the cost was reduced to $14,442,380 in 1949, to $10,251,000 in 1950, and the estimate for 1951 is $9,554,000.

Next to the success of the AEC in its main objective, the Panel makes the maintenance of high standards in community services the paramount consideration. "The interests of the AEC require the presence not only of communities, but of good communities so that there be recruitment and retention of personnel. Thus good schools, good city services of all kinds are as much the interest of the AEC as of the families who live in Oak Ridge and Richland."

THE OBSTACLES TO CONVERSION

The principal obstacles to the disposal of properties and to the incorporation of municipal governments are two: first, the fact that the one industry in each of the places is government-owned and therefore exempt from taxation. On this account municipal authorities would be handicapped in securing sufficient revenues. The second difficulty, according to the Panel, is the possible reluctance of the residents to purchase the homes and business properties and to organize for self-government. To overcome this obstacle the entire program is designed to make the change-over attractive enough so that resident response will be favorable.

THE INDUCEMENTS SUGGESTED

To meet the fiscal difficulty facing the new city governments, the Panel proposes a system of subsidies equal at the outset to the estimated deficits—$1,116,000 at Oak idge, and $1,176,-000 at Richland. The Panel realizes the inequity of these provisions, the smaller sum going to Oak Ridge with its 30,000 people and the larger amount going to Richland with its 23,-000 population. Excessive cost of city operations (exclusive of schools and hospital) at Richaland accounts for this, and a remedy could be found in gradually reducing the subsidy allowed to Richland.

The Panel assumes that economies can be effected by local-citizen control and on this ground foresees reduced budget requirements in coming years with proportionate reduction in subsidies. Transfer of all community service facilities—electrical service, fire-protection properties, water service, etc.—to the new municipal governments without cost is recommended. The transfer would include school properties; the subsidies needed to maintain their present high standard are to be administered by the U.S. Office of Education. Hospital property would be transferred to a non-profit

organization with subsidies administered by the U.S. Public Health Service. A further gift to the new municipalities could be all the vacant lands and lands occupied by temporary houses (the latter to be removed in time according to stipulation); the development and sale of these lands might be an important source of income for the city governments.

To encourage residents to buy homes and business men to buy commercial property it is recommended that easy terms of purchase be adopted; for example, in the case of residential property, 10 per cent in cash and mortgage financing for the balance extending over a twenty-year period at a 4½ per cent interest rate. Still more persuasive is the policy recommended of pricing the properties so that the typical monthly mortgage payments and other costs of occupancy will be less than the monthly rental charges. To induce present tenants to buy the houses they occupy it is suggested that priority of right to purchase be given them for thirty days.

The report says, "In our opinion the most important single step required at present in the two communities is to raise the rents charged in the residential units. The present programs of the AEC leading toward such increases are fully endorsed by the Panel." In February, 1951, the AEC had announced that rents of government-owned housing would be increased about 28 per cent at Oak Ridge and 41 per cent at Richland, effective August 1. These increases, however, have been postponed indefinitely.

To prepare for disposal the Panel recommends classification and description of all real estate which is to be transferred so that each parcel can be identified for pricing and marketing This division of the real estate into units had been initiated at Oak Ridge before the publication of the report; it has now been completed.

A price policy is recommended for both communities which will place property on the market at less than maximum prices prevailing in comparable communities.

A unique provision proposed by the Panel is a guaranty to re-purchase, on request, properties sold under the disposal program if the number of AEC and contractors' workers falls and remains for six months at a level 25 per cent lower than at date of agreement. This is tied to a stipulation that proceeds of property sales be retained by the AEC in a fund so that such requests can be honored. Legislation for such an arrangement, however, might encounter insuperable resistance.

The Panel decided that the incorporation of communities should follow, rather than precede, the disposal of real estate. The Panel places the responsibility for initiating the several steps upon the AEC. Necessary legislation to carry out the changes are pointed out in the report: laws providing financial aids in real- estate sales, laws authorizing financial assistance to the new municipal governments. Both Congress and state legislatures must be approached and persuaded to act in order to free the sundry transactions from future criticism.

A council-manager form of government is suggested. Zoning studies paid for by the AEC is another gesture of good will proposed, and would be

(*Continued on page 96*)

NEW SAFETY-DESIGN FUME HOOD for handling Radioactive Isotopes

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News and Notes

Prepared by Peter Axel

ATOMIC ENERGY COMMISSION NEWS

Budget.—President Truman's $85,444-million budget message of January 21 included a proposed expenditure of $1,775 million for the atomic energy program. This represents only a $50 million increase over the estimated expenditure for the current fiscal year (ending June 30th). However, the President also announced that a five to six billion-dollar expansion program is being planned and will be presented to Congress during its current session. The expansion will take place over a period of about five years and will not require appreciable funds for the current fiscal year.

These figures may be compared with those contained in the *Eleventh Semiannual Report* of the AEC, released on January 30. Up until June 30, 1951, $6,376,-108,752 had been appropriated for the atomic energy program. Of this total, the AEC had expended $2,707,729,756, and there was an unexpended balance of $1,-434,602,201; the remainder had been spent before the AEC was established in 1947. The financial report also contained a figure of $3,557,284,001 for the value of AEC property on June 30, 1951. Hence, the net cost of operations for the first eleven years of atomic energy was $2,805,411,139. This cost includes depreciation and obsolescence of facilities, as well as inventories of source and fissionable materials and atomic weapons.

In discussing the proposed expansion, President Truman made no mention of a possible decrease in the ordinary military budget, which Senator McMahon suggested should become possible through atomic expansion. The proposed 1952–53 budget of $85 billion allots 76 per cent for major national security programs, including 60 per cent for military services. The hope for lower military expenditures was further reduced on February 20, when the Associated Press quoted the House Armed Services Committee as saying that the development of the atomic bomb has made it necessary to train more, not fewer, men for military service.

Reactors.—The *Eleventh Semiannual Report* of the AEC summarized the progress in reactor development for the six-month period ending December 1951. The Experimental Breeder Reactor was completed by Bechtel Corporation and brought up to criticality by the operator, Argonne National Laboratory, at the Idaho site. This is the first large reactor to use fast neutrons. At present, a study is being made of the feasibility of breeding (i.e., of producing more fissionable material than is used in the operation of the reactor). As an incidental part of this reactor development, electrical power was generated from a nuclear reactor for the first time (December 12, 1951). More than 100 kilowatts of electrical power were made available from a steam turbine; the steam was heated by the liquid metal which cools the reactor during operation.

Further announcements concerning this breeder reactor will probably be few and not very informative, according to Chairman Dean. At the AEC press conference on January 28, he said: "I think that from now on out, what we expect to get and when we expect to get it, and whether we are successful in getting breeding out of the reactor is going to be regarded as a very sensitive area, and I don't think we will be saying very much about it."

The report also told of progress on the Materials Testing Reactor which is being built at Arco, Idaho, by the Fluor Corporation. When it is complete, it will produce a more intense neutron flux than any reactor now available.

Another reactor being built in Idaho is the land-based prototype of the Submarine Thermal Reactor. This reactor construction is being supervised by Westinghouse Electric Corporation in consultation with Argonne National Laboratory. Westinghouse will also supply a thermal reactor for the submarine, already named "Nautilus." The Navy's Bureau of Ships has also contracted with Electric Boat Co., of Groton, Connecticut, to construct the hull of the ship and with Westinghouse for the propulsion machinery.

A second land-based prototype of an atomic power plant for submarines was authorized by the AEC on February 21. General Electric was authorized to begin immediate construction at West Milton, New York, of the reactor they have designed, using neutrons of intermediate energy. The Electric Boat Company will be associated with the construction as the submarine builder. This reactor will be housed in a steel sphere, 225 feet in diameter.

Appointments.—Eugene M. ZUCKERT, Assistant Secretary of the Air Force, was nominated by President Truman on January 31 to be a member of the Atomic Energy Commission. The nomination of Mr. Zuckert, who will fill the unexpired term of Sumner T. Pike, was confirmed by the Senate members of the Joint Atomic Energy Committee on January 29.

Major General Thomas F. FARRELL, who has been assistant general manager of the AEC for the past seven months, resigned on February 12, 1952. He will become the managing director of ARO Inc., which manages and operates the government-owned Arnold Engineering Development center at Tullahoma, Tennessee. (This center, still under construction, is to be the major engineering test station of the Air Force.)

Dr. John VON NEUMANN, renowned physicist and mathematician, was named by President Truman on February 27 as a member of the General Advisory Committee to the AEC. Dr. von Neumann is one of the staff at the Institute for Advanced Study in Princeton. He will fill the unexpired term of Professor Cyril SMITH of the University of Chicago, who resigned on January 26.

INTERNATIONAL NEWS

Exchange of information.—Canada and the United States are exchanging information in a specific but unannounced area of atomic activities. The exchange, which began in January, is the first to take place with any foreign power since the Atomic Energy Act went into effect. It is made possible by an amendment to the Act passed during the last session of Congress (printed in the January *Bulletin*, page 16.)

Chairman Dean of the AEC said, during the January 28 press conference, that Lord Cherwell had been informed of the details of the amended act to facilitate possible future exchanges with Britain. However, the only exchange authorized at present is the one taking place with Canada.

British bomb tests.—Great Britain will test her own atomic weapon in Australia, probably sometime in September or October. The original announcement that Britain was ready to make such a test was made on February 17. Two days later, two Navy ships, laden with equipment and technicians, sailed for Australia. Authoritative sources indicate that Britain could have used our Nevada testing site but preferred a proving ground within the British Empire.

Prime Minister Churchill, speaking before Parliament on February 26, emphasized the prestige involved in Britain's fa-

cilities for making bombs. Mr. Churchill said: "I was not aware until I took office that not only had the Socialist government made the atomic bomb as a matter of research, but that they had created at the expense of many scores of millions of pounds, important plants necessary for its regular production."

"This achievement is certainly of real advantage to us, and when I informed the Americans in Washington of the position which had been reached, a new atmosphere was created on this subject."

Since it has been well known that the British have had plutonium production piles in operation for some time, Mr. Churchill's assertion of his supposed ignorance sounded somewhat unconvincing. Possibly, despite the availability of Lord Cherwell's advice, Churchill was truly unaware of the significance of these production reactors. More likely, however, Mr. Churchill was attempting to spotlight British achievements so as to obtain the maximum political advantage from them.

In making the announcement, Mr. Churchill also took the opportunity of pointing out that the Socialist government had emphasized weapons research in their administration of atomic policy.

ATOMIC WEAPONS

Tactical bombs.—The Army has made a start, but only a very preliminary one, in educating officers and enlisted men in the changes in warfare caused by the existence of tactical atomic weapons. Public discussion of tactical atomic weapons has assumed that these will be available for use in large numbers; but only two simulated bombs were used in the February maneuvers at Camp Drum, N.Y. The "aggressor" forces used one bomb on February 14, and an early evaluation of casualties and equipment totaled about one-fourth of the regiment under attack. On the basis of umpire reports, General Crittenberger, the officer in charge of the war games said: "The damage in this instance is assessed to be sufficient to cause a serious modification of plans for the employment of the troops in this area." The second simulated atomic bomb was used on February 15 as part of an exercise in which the "defending forces" completed their victory.

Hanson Baldwin, in the *New York Times* (February 5), said that "No physical description of the weapons is given and the effects described are drawn from the unclassified Weapons Effects Handbook published by the AEC and are not the considerably different effects of new weapons tested in Nevada." Lieutenant General Keyes, head of the Weapons Systems Evaluation Group of the Defense Department, observed the tests and commented, "You are pioneering with a weapon so new and so costly that you can't fire it as a pistol."

One achievement of the maneuvers, which will have only limited applicability in real warfare, is the development of "A-bomb simulation" technique. It involved three simultaneous events: (1) a photoflash bomb was dropped by a reconnaissance bomber; (2) a TNT charge was detonated on the ground; and (3) three F-51 fighters lay down a smoke screen.

Future bomb tests.—A new series of atomic tests, to be held at Eniwetok, are being planned by the AEC and the Defense Department. The tests will be conducted under the over-all command of Major General Percy W. Clarkson.

Polyanna.—Tactical atomic weapons, "tailor-made for size and use," will effectively neutralize the manpower superiority of the totalitarian nations. This was the thesis presented by New York *Times* reporter, William L. Laurence, to a group of teachers on February 27. Mr. Laurence said: "World War III has become impossible, and, in a sense, by making it impossible, it has been fought and won."

NATIONAL SCIENCE FOUNDATION

Next year.—$15,000,000 were requested by President Truman for the National Science Foundation for the next fiscal year. The budget message informed Congress that the NSF is expected to become the focal point for federal support of basic research and that the budgets of other agencies supporting research have been adjusted in the light of the NSF request. The House Appropriations Subcommittee on Independent Offices has already considered the request. The subcommittee will report to the full committee which will then make recommendation to the House.

The Subcommittee's members are Albert Thomas (D., Tex.), chairman, George Andrews (D., Ala.), Norris Cotton (R., N.H.), Frederic Condert (D., N.Y.), Albert Gore (D., Tenn.), John Phillips (R., Cal.), and Sidney Yates (D., Ill.).

This year.—The first research grants to be made by the NSF were announced by the biological division on February 8. The 28 grants awarded to 17 institutions totaled $410,000, represented a little less than 40 per cent of the research funds available under the current budget. The size of the individual grants varied from $780 to $50,000; the time duration varied from one to five years. The average length of a grant is 2.3 years and the average size was $6,300 per grant per year.

Last year.—There has appeared recently the *First Annual Report of the National Science Foundation*, covering fiscal 1950–51. Because of the well-known difficulties of the Foundation in its troubled first year of life, there is little to report beyond the list of functions the Foundation hopes to perform—to develop a national policy for the promotion of basic research and education in the sciences; to suport basic scientific research and to appraise the impact of research upon industrial development and the general welfare; to support specific defense research activities; to award scholarships and graduate fellowships in the sciences; to foster the exchange of scientific information; to maintain a register of scientific and technical personnel, and to serve as a central clearinghouse for such personnel; to evaluate scientific research undertaken by federal agencies and to correlate the Foundation's research programs with other such programs; to cooperate in international scientific research activities.

Since the publication of the Foundation's *Report*, news stories of the processing of applicants for 500 graduate fellowships, and the granting of some 28 research grants to applicants, indicate that action has commenced on the parts of the program most directly touching the general scientific public.

It is interesting to read at the same time the *Fourth Annual Report of the Advisory Council on Scientific Policy* (London: H. M. Stationery Office, 1951. Cmd. 8299. Nine pence), covering the same calendar period. The British Advisory Council is a body whose function is solely that of giving advice to the government on matters of science and scientific policy. It is composed largely of scientists, and enlists the aid of other scientists for special committees, through which much of its work is done. Although its advisory nature differentiates it from the National Science Foundation in this country, it concerns itself with many of the same problems. Thus, some of the items discussed in the report are scientific manpower, higher technological education, government scientific organization, the Colombo plan (results of a meeting in Colombo regarding the economic development of South and Southeast Asia), overseas scientific relations, scientific libraries and technical informations services, toxic substances in consumer goods, atomic energy, and priorities in research.

The principal difference, therefore, lies in the active functions of the Science Foundation—disbursement of fellowships and scholarships, granting of research funds, etc. The apparent ability of the Advisory Council to obtain the assistance of some of the biggest names in British science in forwarding the word of its committees, and in keeping its work at a high level, gives an objective on which the infant National Science Foundation may well set its sights.

Note to Readers—

News for this section should be sent to Dr. Peter Axel, Department of Physics, University of Illinois, Urbana, Ill. The deadline is the 1st of each month.

Letters to the Editor

DEAR SIR:

In view of the fact that you are protesting aspersions on the loyalty of scientists, I think the second paragraph in your editorial "How To Lose Friends," was unfortunately phrased.

"These incidents," you say, are "helpful to those who want America to be looked upon as a country ruled by reactionaries who fear 'subversive' foreign thought as it was feared . . . by Muscovite Czars before Peter the Great."

Would it not have been more politic, and also more immediately applicable, to have referred instead to the Kremlin and Stalin? The Czars and their suspicion of foreign thought are dead; Stalin and the intellectual quarantine imposed by the Soviet Union are very much alive.

I sympathize with your protest. That is why I am sorry that you have, to this extent, offered the opposition a vulnerable phrase. It suggests that while you are hard on American inhospitality you ignore it in an even more aggravated forms elsewhere. I am sure you did not intend to convey this implication, but on several readings I can gain no other inference.

Respectfully yours,
EDWARD F. BATAILLE
Newark, New Jersey

Editor's Note—

A main purpose of the* Bulletin *is to serve as a forum of opinion.

Therefore the* Bulletin *invites reader's comments, not only upon its articles, but upon the current developments in science and society.

Address: Dr. Eugene Rabinowitch, Editor,* The Bulletin of the Atomic Scientists, *956 E. 58th St., Chicago 37, Illinois.

DEAR SIR:

Because the *Bulletin* "does not represent the official views of any organization" and is not formally responsible to a broad electorate among scientists, there is a danger that the policies of this influential publication become centered around narrow interests. Moreover, the very name *Bulletin of the Atomic Scientists,* as well as its close association with the Federation of American Scientists in the early days of their development, implies a responsibility to furnish American scientists with a well-balanced cross-section of opinion.

We have observed a continual and accelerating drift toward one-sidedness in the selection of material for publication in the *Bulletin;* this drift has kept pace with the tempo of the armaments race and the development of a war psychology. For example, it has been a long time since the viewpoint of a J. D. Bernal or a Frederic Joliot-Curie has been given serious consideration in the pages of the *Bulletin,* although these and other respected scientists are saying things about world peace which cannot safely be ignored.

In general, our press does ignore the words of these people on the pretext that they speak only in the interests of some nether-world entirely incompatible with ours. It would seem dangerous for Americans, with but 7 per cent of the world's population, to attempt the exclusion from humanity of nearly one-half of that population; it is equally dangerous to exclude from our thinking certain approaches to world peace merely because they have been stamped "subversive" by our censors.

The *Bulletin* could render a great service to its readers and to the cause of world peace if it were to give greater weight to the ideas from the other half of humanity and to promote actively the search for a common ground between the two halves.

We wish to suggest a few small beginnings with which to test the idea. For example, we urge you to re-print the article in the November 1951 issue of the "New World Review" by Professor Kathlen Lonsdale, the eminent crystallographer. Miss Lonsdale was a member of the recent British delegation of Quakers to the Soviet Union.

Equally important and timely, we believe, is a letter written by a former member of the Federation of American Scientists who worked at Los Alamos and at the Institute of Nuclear Studies; and who has been in China since 1948, Joan Chase Hinton. Her recent letter to a member of the Federation was published in the September 16, 1951, issue of "People's China." We urge you to find space for this in an early issue of the *Bulletin.*

Finally, in the belief that many other readers may wish to make suggestions about editorial policy, we ask that our letter be printed in the *Bulletin.*

Sincerely,

NORMAN BAUER
LEONARD T. POCKMAN
Berkeley, California

★ ★ ★

Editor's Note—

Dr. Joliot-Curie last appeared in the pages of the Bulletin *in October 1950, a year and a half ago. A few months ago he was asked to do another article for us but he replied, as many of our prospective authors do, that he was too busy with his laboratory and other work; we printed an article by Professor Lonsdale in our August issue, and another which we sought from her concerning her trip to Moscow appears in this issue; the "Joan Hinton Letter" has been under consideration for some months, but until recently it was not clear that we were free to publish it.*

FUTURE OF AEC COMMUNITIES

(*Continued from page 93*)

sound policy to provide guidance in early operations.

The Panel's report has had a wide circulation and has been much discussed in both communities. One of the first interests of the householders has naturally been in the question, "What will it cost to purchase the house I now rent?" Within the past ninety days a team of appraisers, members of the Knoxville Real Estate Board, has made an appraisal of 185 sample units at Oak Ridge, and a list of the estimated market value of these samples will be made public.

The report should be extremely helpful. If it errs, it is in being too specific in details and leaving too little for the community meetings and discussion groups (which the report advocates) to decide. The declaration of Senator Milliken before the Joint Atomic Energy Committee that such things as community organization "took care of themselves," represents the opposite attitude toward government planning for the people. It may be an extreme, but the American people are happier if they are allowed to plan by themselves and make their own mistakes.

Do You Know What Is At Stake?

THE CLIPPING REPRINTED ON THE BACK OF THIS page is from *The Christian Science Monitor*. It was written by Roland Sawyer, now a Washington correspondent of that distinguished paper. Mr. Sawyer, like some 200 other correspondents and editors—including Elmer Davis, Norman Cousins, Hanson Baldwin, Drew Pearson, Edward R. Murrow—is a devoted subscriber to the *Bulletin*.

THIS MAGAZINE'S EDITORS cannot in all modesty agree with the glowing encomiums so kindly sent our way from the *Monitor*, but certainly many of our contributors do realize much better than the average person *what is at stake in the cold war and the arms race*. We would add to Mr. Sawyer's analysis that it is not alone what our Board of Sponsors and our writers *know*—it is what they *feel* about the issues of peace and atomic war which give the *Bulletin* its distinctive character.

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Men Who Really Know What Is at Stake

An Intimate Message from Washington

Registered in U. S. Patent Office

By Roland Sawyer

WASHINGTON

A recent issue of Collier's Magazine devoted exclusively to the "next war" has evoked numerous responses in Washington, some humorous, some critical. Perhaps the publication most eligible to reply to Collier's is the Bulletin of Atomic Scientists, a monthly circulating chiefly in the professional science world but one that could be read profitably in nonprofessional circles. Every issue of the Bulletin of Atomic Scientists has at least one article of importance to the general reader.

You won't find humor in its pages, unless your sense of humor is of the Charles Addams variety. Occasionally its editors will insert a cartoon from the New Yorker, but not by Mr. Addams. Otherwise its pages, beginning with the cover depicting hands of a clock pointing to three minutes to midnight, carry serious, sometimes ponderous but stimulating articles by men whose applied knowledge represents, in many respects, the greatest human power existing on the face of the globe.

* * *

This correspondent has saved nearly every issue of the Bulletin of Atomic Scientists since its inception in 1945. In another generation these early issues containing the writings, opinions, hopes, and despairs, of the pioneers in this totally new world may be of as great interest and importance as the periodicals and papers published in the days of Franklin, Adams, Washington, and Jefferson.

You can find in many issues of the Bulletin of Atomic Scientists articles that offer ground for far greater concern than Collier's depiction of an atomic war between the United States and the Soviet Union. To be sure, Collier's used color illustrations aplenty. But read a few of the issues of the Bulletin—wnere the facts of life in the atomic age are not concealed, even if the type is small—and you'll understand why the atomic scientists of the United States are as serious as well as high-minded a group of men as there is in our society. They really know what is at stake.

Take, for instance, the issue of November. It contains, in addition to the answer to Collier's, a long and thoughtful essay on fear and how it has spread across the land to hamstring not only the best efforts of nuclear scientists but of all professional groups. There is part two of a long series of excerpts from the Forrestal diaries, containing those sections dealing with the atomic bomb and its possible application if the cold war should spread. (Segregating a single topic from Mr. Forrestal's diary strikes me as extremely useful and helpful.)

Other articles discuss the electric power industry and the AEC, the fire effects of atomic bombs, what people are thinking, and so on. There are also book reviews, not of techncial literature but of political and social interest.

For the Bulletin is not a technical magazine. It is the medium in which the nuclear scientists can, so as to speak, think out loud about what they are doing and why, ask the $64 questions, and answer them if or as they can.

* * *

On the Collier's war issue, the Bulletin comments:

"This issue was advertised as one which may 'change the course of history'—as the editors explained, by presenting to the Soviet leaders the dreadful consequences of their rash action and their ultimate defeat. To our minds, it is more likely to provide them with authentic material for propaganda against 'American warmongers.' What can be more welcome to Soviet propagandists than a whole page picture of the atomic destruction of Moscow?"

This magazine also, continues the Bulletin, "could be put to good use to frighten Russian intellectuals with the fate America intends for them. This picture will not be lost also on the intellectuals of western Europe, whose fear of the strait jacket of Soviet intellectual dictatorship is easily balanced by their aversion to what they consider American mass-produced civilization."

American nuclear scientists who built the first bomb and are devising the atomic weapons that we now hear about are not, therefore, happy about any magazine article which could create fear and concern at home or could be used (they believe) to twist the nonaggressive role of the United States abroad into the opposite.

The point is not whether the nuclear scientists are right. Rather, it is that the nuclear scientists are constantly striving to make their influence felt upon the course of political events at a high level at home (as they did in the passage of the United States Atomic Energy Act of 1946), and to speak to their counterparts, as well as to all men, abroad. The Bulletin of Atomic Scientists is one, probably the most consistent available medium, for so doing.

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